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FM 55-9

UNIT AIR MOVEMENT PLANNING

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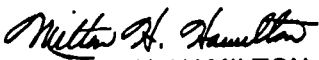
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Field Manual
No. 55-9

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UNIT AIR MOVEMENT PLANNING

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PREFACE

This manual provides guidance for Army personnel involved in unit movement on Air Force-provided airlift, including commercial charter and Civil Reserve Air Fleet (CRAF) aircraft. It gives an overview of air transportability considerations for Army personnel and equipment and describes aircraft loading procedures and related fundamentals and techniques. It provides in-depth information on aircraft characteristics, the 463L pallet system, and CRAF.

This manual, with FM 55-12, AMC Pam 55-41, and TM 38-250, gives unit commanders and movement personnel the basic data to plan and execute successful movements via airlift.

The proponent of this publication is the US Army Transportation School. Send comments and recommendations on DA Form 2028 (Recommended Changes to Publications and Blank Forms) to Commandant, US Army Transportation School, ATTN: ATSP-TDL, Fort Eustis, VA 23604-5389.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

CHAPTER 1

INTRODUCTION TO AIR MOVEMENT**INTRODUCTION**

Air movement is initially the primary transportation method used during crisis response. World situations that call for a rapid response by the armed forces use airlift to quickly move to an area of operations. Air movement of units requires detailed planning at all levels of command. This chapter gives a brief overview of the history of airlift and air movement missions and responsibilities. It also provides general instructions for conducting an air movement, emphasizing safety.

Air load planners must successfully complete one of three airlift planning courses to be certified to plan and sign DD Form 2130-series cargo manifests. These courses are the AMC Affiliation Airlift Planners Course, the US Army Air Deployment Planning Course (ADPC), and the USMC Landing Force Training Command Pacific (LFTCPAC) Aircraft Load Planning Course. According to AMC Regulation 55-3, this certification is valid for two years after completion of the course. As of the date of this publication, recertification procedures have not been defined. Consult the original training source for further details.

HISTORY OF AIRLIFT

Airlift has played an important part in nearly every major conflict since World War I. Throughout World War II, in all theaters of operation, commanders frequently airlifted troops and supplies. The Berlin Airlift was the first real test of airlift operations in a noncombat role. Without airlift, the Soviet Union would have been able to starve West Berlin into submission. Commanders in the Korean conflict used airlift to resupply many of the United Nations' forces. Our modern airlift force was developed during the Vietnam War, with modern, faster, and more efficient airlift replacing earlier models. Early in the Vietnam War, it took days to transport a few thousand pounds of cargo from the United States to the battle area. At the end of the war, more than 200,000 pounds could be transported the same distance with one airplane in less than 24 hours. During Operations Desert

Shield/Desert Storm, more than 509,000 passengers and 700,000 tons of cargo were moved by more than 18,500 airlift missions.

AIR MOVEMENT AUTHORITY

AR 220-10 specifies who has authority to authorize unit air movement. The Joint Chiefs of Staff (JCS), in coordination with the Department of Defense (DOD) and the Department of the Army (DA), authorizes unit air movement between overseas major Army commands or from an overseas major Army command to the continental United States (CONUS). Headquarters DA authorizes unit movement by air from or within CONUS. DA normally provides instructions and movement authority to the Army components of unified commands to implement DOD and JCS directives.

DA publishes the movement directive. This basic document is the authority for the appropriate commander to prepare a unit for movement and to execute the move.

DEPLOYMENT INSTRUCTIONS

Army major commands or Army components of unified commands issue deployment instructions as a guide for the moving unit. These instructions generally cover criteria for deployable personnel, type of equipment to be taken, medical support to be provided, and special logistical and soldier support instructions. AR 220-10 outlines standard procedures for preparation for overseas movement (POM). Data in this manual are consistent with AR 220-10.

TYPES OF MOVEMENTS

The type of movement is based on the urgency of the situation. The type of movement directed in the deployment instructions determines the method of loading. The two types of movement are nontactical movements and tactical movements.

Nontactical Movement

A nontactical movement is a movement in which units, personnel, equipment, and materiel

move when no enemy interference or contact is anticipated. It emphasizes economical use of the aircraft cargo space and maximum use of the allowable cabin load (ACL). ACL is the amount of cargo and passengers (as determined by weight, cubic displacement, and distance from origin to destination) that may be transported by a specific type of aircraft. Unit integrity and unloading sequence are major considerations when planning a nontactical movement, but efficient economy of space utilization has the highest priority (Figure 1-1). Units may not be required to be operational upon unloading.

Tactical Movement

A tactical movement is a movement of units, personnel, equipment, and materiel that is organized, loaded, and transported to facilitate accomplishment of a tactical mission. Unit integrity is the primary consideration in movement, not economy of space. Maximum use of the aircraft ACL remains the ultimate movement goal, but the commander's sequence of employment and unit integrity receives the highest priority. Units should be configured to conduct immediate operational missions upon unloading (Figure 1-1).

SAFETY

Commanders and all personnel must emphasize safety and use the principles of risk management when making decisions. Safety in training and execution is *force protection*. Protecting the force through risk management means performing to standards, correcting unsafe behavior, and making good risk decisions. Vehicle accidents kill 250 soldiers and cost the Army \$100 million dollars each year. These losses are preventable by taking the proper precautions. The first fatality in Operation Desert Shield was an Air Force airman struck by a vehicle on the flight line.

FM 55-12 covers specific safety measures during aircraft loading. Other safety rules are below.

Troop Movement on an Airfield

Before troops move onto an airfield, airfield operations personnel grant permission and the movement is coordinated with designated airfield personnel who provide guides or appropriate instructions. Troops move on the airfield in controlled formation only; halt at least 100 feet from

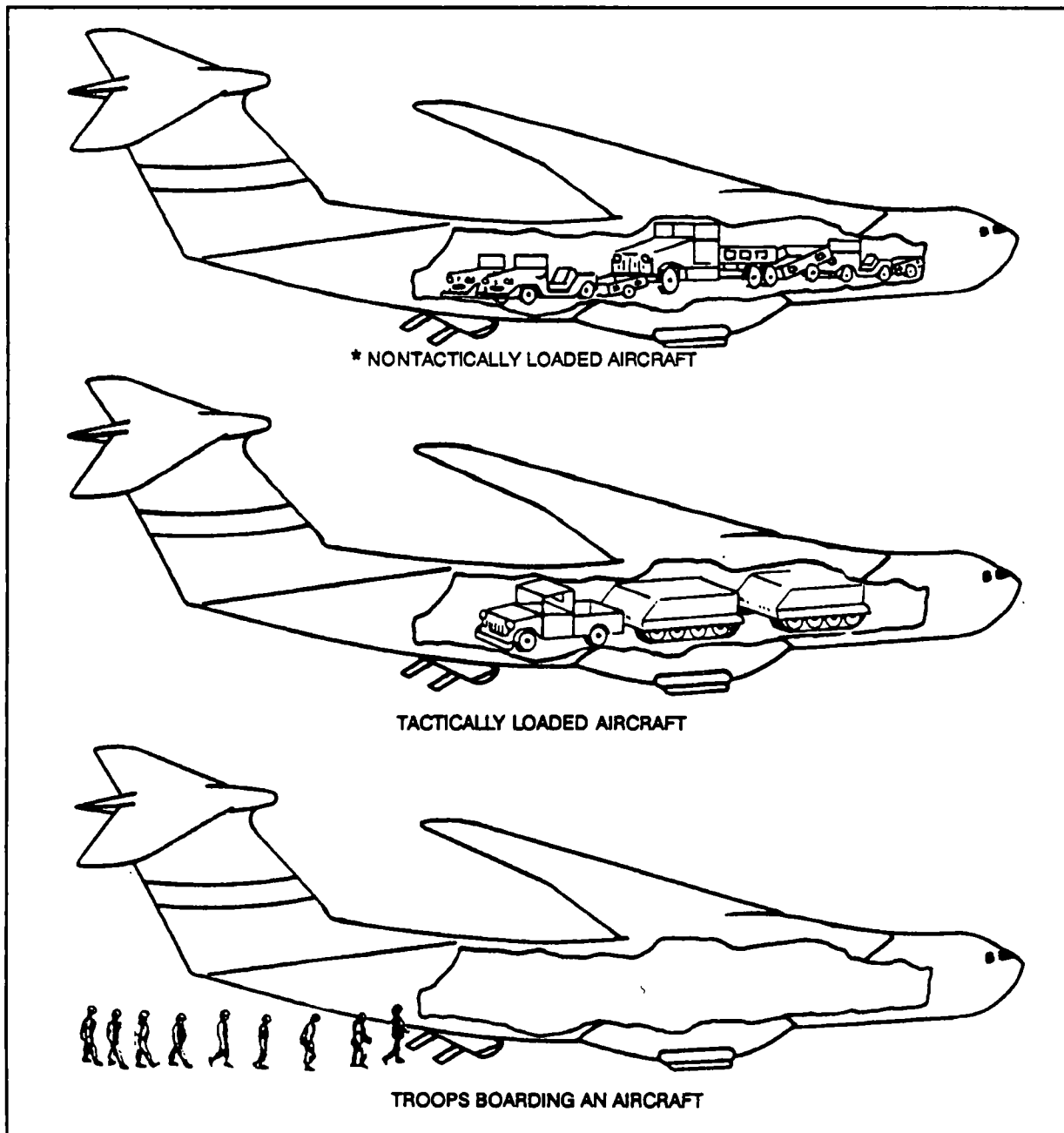
the edge of runways, taxi strips, and ramps; and get clearance before crossing. The Tanker Airlift Control Element (TALCE) may identify entry control points (ECPs) for access of troops onto flight lines.

Flight Line Safety

Personnel on the flight line—

- Must not smoke on the aircraft parking ramp area except in designated smoking zones.
- Must not walk in front of any aircraft when the engines are running. Personnel must never walk within the propeller arc.
- Must walk around the outside of the wing tips to avoid the auxiliary power units' blast or heat exhaust and the propeller or jet intake area.
- Must observe a 15 mph speed limit for all vehicles on the flight line.
- Must observe a 5 mph speed limit for all vehicles within 25 feet of an aircraft. However, the speed of vehicles will not exceed 3 mph (walking speed) when within 10 feet of the aircraft, to include movement inside the aircraft.
- Must not approach within 50 feet of an engine intake nor within 200 feet of the blast area to the rear when jet engines are running. On propeller-driven aircraft, the danger area is 10 feet in front of the propeller and 200 feet to the rear.
- Must not drive any vehicle under any part of the aircraft.
- Must not drive a vehicle within 10 feet of an aircraft without a walking guide to observe clearance between vehicle and aircraft. This "circle of safety" extends 10 feet in front of the nose, 10 feet behind the tail, and 10 feet outboard of each wing tip (Figure 1-2).
- Must not drive vehicles, except those being loaded or unloaded, directly toward an aircraft or park closer than 10 feet from an aircraft.
- Must approach an aircraft in a vehicle with the driver's side nearest the aircraft. Personnel park the vehicle perpendicular to the aircraft fuselage.

- Must not allow trash or debris to be thrown on the flight line. Personnel must also ensure that canvas or small pieces of equipment are secure to prevent the jet exhaust from blowing them around.
- Must not stand or walk directly in front of or behind vehicles being driven or backed into the aircraft.
- Must not back vehicles toward or into an aircraft without spotters placed at the front and rear corners of the vehicle. (The aircraft loadmaster directs all backing.) Spotters should not be directly in front of or behind any moving vehicle.
- Must not stand between a moving vehicle and any stationary object, such as another vehicle, aircraft, or buildings.



*Figure 1-1. Types of Movement.

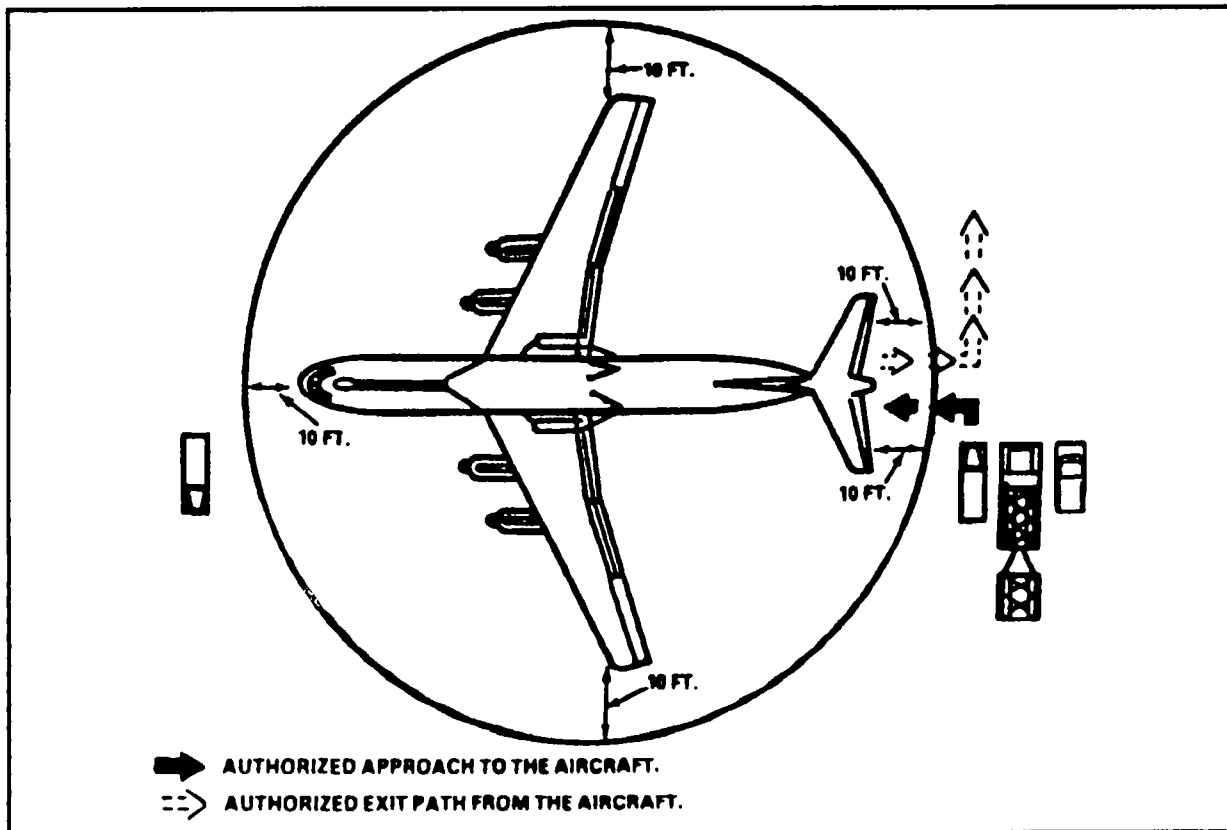


Figure 1-2. Circle of Safety.

Risk Management

Risk management is the process of making operations safer without interfering with essential mission values. The process focuses a leader on issues that could result in losses and then requires the leader to consider risk reduction measures that allow mission accomplishment while minimizing losses. The four principles of risk management are—

- Accept no unnecessary risk. An unnecessary risk is one that if eliminated would still allow for mission accomplishment.
- Make risk decisions at the proper level consistent with your local command policy.
- Accept risk only when benefits outweigh costs.
- Manage risk in the concept and planning stages whenever possible.

The risk management process is to—

- Identify the hazards that will be encountered.
- Assess the risk of those hazards by asking what are the most likely injuries or damage that might occur, and what is the probability of those losses.
- Determine what kind of control measures could be used to reduce risk. These might be speed limit controls, more supervision, scheduling, route changes, protective equipment, more training, or more indepth instructions. Once available controls are considered, decide which of those controls to implement.
- Implement controls.
- Supervise. Remember that NCOs make it safely happen.

CHAPTER 2

AIR MOBILITY COMMAND AIRCRAFT

INTRODUCTION

This chapter describes Air Mobility Command (AMC) aircraft and provides the necessary planning data to effectively prepare load plans. Personnel who prepare load plans must recertify every two years.

The AMC aircraft of main concern are the C-130, C-141, C-5, KC-10, and C-17. With some exceptions, their cargo compartments can be configured to hold general bulk or palletized cargo, vehicles/equipment, troops, paratroopers, or cargo rigged for airdrop. The KC-10 cannot be rigged for airdrop. The wide range of cargo carried by these aircraft, along with many options for loading, provides great flexibility in moving troops and equipment.

Each of these aircraft have medium- to long-range mission capability. All are equipped with roller conveyor systems for using the 463L pallet system. The C-130, C-141, C-5, and C-17 have hydraulically activated ramp systems to ease loading and unloading. The C-141, C-5, KC-10, and C-17 also have aerial refueling capability.

NOTE: The planning data for the C-17 are projected capabilities only. They do not reflect the results of any DOD-certified tests and evaluations. Use only current data as a reference for possible future capabilities. Consult affiliated AMC representatives for actual "fly away" data.

ALLOWABLE CABIN LOAD

The load planner must know the approved allowable cabin load for a particular aircraft. ACL is the weight of unit personnel, equipment, and materiel that an aircraft can carry. Several varying factors, such as distance, route to be flown, fuel load, weather, and winds, impact on the ACL. Departure and arrival airfield characteristics also factor into determining the ACL.

For general airlift planning factors, use the following ACLs:

<u>AIRCRAFT</u>	<u>ALLOWABLE CABIN LOAD</u>
C-130	25,000 pounds
C-141	50,000 pounds
C-5	150,000 pounds
KC-10	100,000 pounds
C-17	153,500 pounds

AIRCRAFT CENTER OF GRAVITY LIMITS

Another factor to consider in load planning is center of gravity (CG) limits. Each aircraft has certain limits in which it must be balanced. If an aircraft is not balanced properly, it may not take off or land safely. In extreme cases, it cannot fly safely. The load planner directly affects this balance factor when loading cargo aboard an aircraft. Loads must not cause the aircraft to exceed its balance limits. The CG of any aircraft is the point on the aircraft at which the aircraft would hang in a level, balanced horizontal position if hoisted off the ground by a cable. It is an exact and specific point on the aircraft. Fortunately, through design characteristics and mechanical devices, each aircraft allows some variation with its CG. Otherwise, load planning would be almost impossible.

These variations, or CG limits, provide the load planner with flexibility in preparing various load configurations for each aircraft. As long as the effect of the cargo weight is kept within these CG limits, the aircraft can be safely operated.

CARGO LOAD CENTER OF BALANCE
LIMITS

To keep the cargo weight within the aircraft CG limits, the cargo load center of balance (CB) must be identified. The combined center of balance (CCB) of the cargo load is then placed in the cargo compartment within a prescribed design limit for the aircraft. (See Chapter 5 for more

information.) Table 2-1 provides AMC guidelines for use in airlift planning.

In general, floating CB criteria means as the cargo weight increases, the total cargo center of balance windows decrease. When total cargo weights fall between given weights, use the most restrictive (next higher) center of balance window. For example, a 46,000-pound load on a C-141 uses the 50,000-pound window of 880-950.

Unit air movement planning personnel must comply with established planning data when load planning unit equipment and personnel deployments by air.

The CB window numbers are referred to as fuselage station (FS) numbers. They represent the distance (in inches) aft from the aircraft reference datum (RD) line at which point the cargo load

must balance. The FS numbers are clearly marked on the cabin walls to use as reference points when loading.

AIRCRAFT CHARACTERISTICS

Load planners must consider the characteristics of each aircraft. These characteristics include-

- The size of the cargo door and its location and height above the ground.
- The size and shape of the cargo compartment.
- The strength of the aircraft floor.
- The location, number, and type of seats available for airlifting troops.
- Aircraft configurations (Appendix A).

***Table 2-1. Floating Center of Balance Criteria.**

<u>WEIGHT</u>	<u>C-130</u>	<u>C-141</u>	<u>C-5</u>	<u>KC-10</u>	<u>C-17</u>
5,000	400-550	630-1000	400-1000	530-840	350-960
10,000	400-550	770-1000	400-1000	530-1105	350-940
15,000	475-530	770-1000	400-1000	542-1238	350-930
20,000	485-530	835-970	400-1370	542-1238	350-930
25,000	510-530	835-970	400-1370	810-1205	360-925
30,000	510-530	860-960	670-1380	810-1205	450-925
40,000	515-530	870-950	835-1380	942-1252	560-925
50,000		880-950	935-1380	1022-1280	620-925
60,000		890-950	1000-1380	1075-1298	630-920
70,000		890-940	1050-1380	1115-1311	690-920
80,000			1085-1390	1142-1321	720-920
90,000			1115-1390	1165-1329	740-920
100,000			1135-1390	1162-1335	750-920
120,000			1170-1390	1210-1345	770-910
150,000			1200-1390	1234-1354	810-900
175,000			1225-1390	1235-1354	830-900
245,000			1280-1390		
291,000			1315-1390		

If a complete file of Air Force publications is not available, the unit's affiliated AMC Airlift Control Squadron (ALCS) will assist the load planner. The ALCS is an extension of the unit's staff for all

airlift planning. See FM 55-12 for more information on the affiliation program.

Table 2-2 is a quick reference for AMC aircraft. Refer to the individual aircraft discussed later in this chapter for more detailed information.

*** Table 2-2. AMC Aircraft.**

Model Design	C-130	C-141	C-5	KC-10	C-17
Manufacturer	Lockheed	Lockheed	Lockheed	McDonnell Douglas	McDonnell Douglas
Popular Name	Hercules	Starlifter	Galaxy	Extender	Globemaster III
Cargo Compartment Dimensions					
Length (inches)	624	1,251	1,733	1,508	1,075
Height (inches)	108	109	162	108	148 ¹ 158 ²
Width (inches)	123 ³	123	228	218	216
Aircraft Ramp Length (inches)	132	133	(Fwd) 116 (Aft) 155	None	257
Usable Loading Space (inches)	597	1,215	1,726	1,416	1,022
Troop Load					
Over land	90 ⁴	200	73 ⁵	10 (B) 69(D)	54 SF 102 SL 158 DL
Over water	80 ⁶	160 ⁶	73 ⁵	69	102

¹Under and forward of the wing box.
²Aft of the wing.
³With dual rails installed, the cargo compartment floor is limited to 106 inches wide for cargo loading.
⁴Troop seating, except seat 11 left and 11 right must be installed in pairs.
⁵Troop seating in the overhead troop compartment.
⁶Total number of personnel (including flight crew) allowed during over-water flights due to the number of emergency ditching exits.

Legend
SF - Side-facing seating only
SL - Single centerline and side-facing seating
*DL - Double centerline and side-facing seating

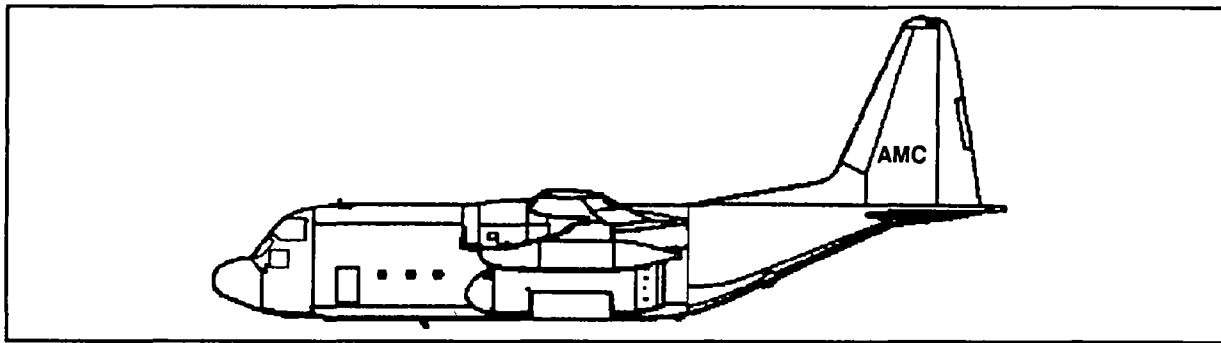


Figure 2-1. C-130 Aircraft.

***Passenger Considerations.** The C-130 does not have a separate passenger compartment, and passengers compete for available ACL. For planning purposes, estimate each passenger to weigh 210 pounds. This weight may vary with type of mission (refer to FM 55-12) and should be confirmed with AMC as early as possible. When using side-facing seats, plan for a maximum of 29 passengers. The C-130 will carry a maximum of 90 passengers (80 including flight crew for over water flight).

NOTE: Side-facing seats number 1 through 10 and 13 through 22 left and right must be installed in pairs. Seats 11 and 12 must be installed with 10 and 13 respectively, as these seats will not stand alone.

Palletized Cargo Restrictions. The C-130 can accommodate up to six 463L pallets. Usable surface dimensions of a 463L pallet are 84 inches long by 104 inches wide. Pallet criteria according to position, weight, and height are in Figure 2-2.

For pallet positions 3 and 4, maintain a 6-inch aisle along the narrow side of the pallet. Do not exceed an overall dimension of 84 inches long, 98 inches wide, and 96 inches high. This will provide the necessary aisleway for emergency exit of the aircraft.

For pallet position 6, maintain an 18-inch aisle. Pallet cargo dimensions will not exceed 86 inches wide, 84 inches long, and 76 inches high. This provides access to the latrine, cargo loading aids stowed in the cargo door, and to the aft escape exit hatch on the aft end of the cargo ramp.

Loading Guidance. The cargo area dimensions in Figure 2-3 are for general planning purposes only.

Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual. The schematic in Figure 2-3, extracted from DD Form 2130-2 (C-130 A/B/E/H Cargo Manifest), shows the fuselage station numbers and pallet position center of balances.

A number of loading aids are available to more conveniently load the C-130. They either come with the aircraft or are available as options from the supporting AMC TALCE or servicing aerial port. In addition to the primary loading aids in Figure 2-4, the following aids are available (all but the wheeled pry bars are in the aircraft):

- Wheeled pry bars for handling boxes and crates in the cargo compartment.
- A portable electric winch for moving cargo in and out of the aircraft.
- Internal electrical power outlets to provide power for aids when loading the aircraft.
- An auxiliary power unit to provide electricity and hydraulic pressure to assist aircraft loading.
- A public address system consisting of loudspeakers, microphones, headsets, and extension cords for giving loading instructions and to control the loading operation.
- Lighting to illuminate the cargo compartment and door area during night loading.
- Snatch blocks (loading pulleys) to help move cargo in and out of the aircraft.

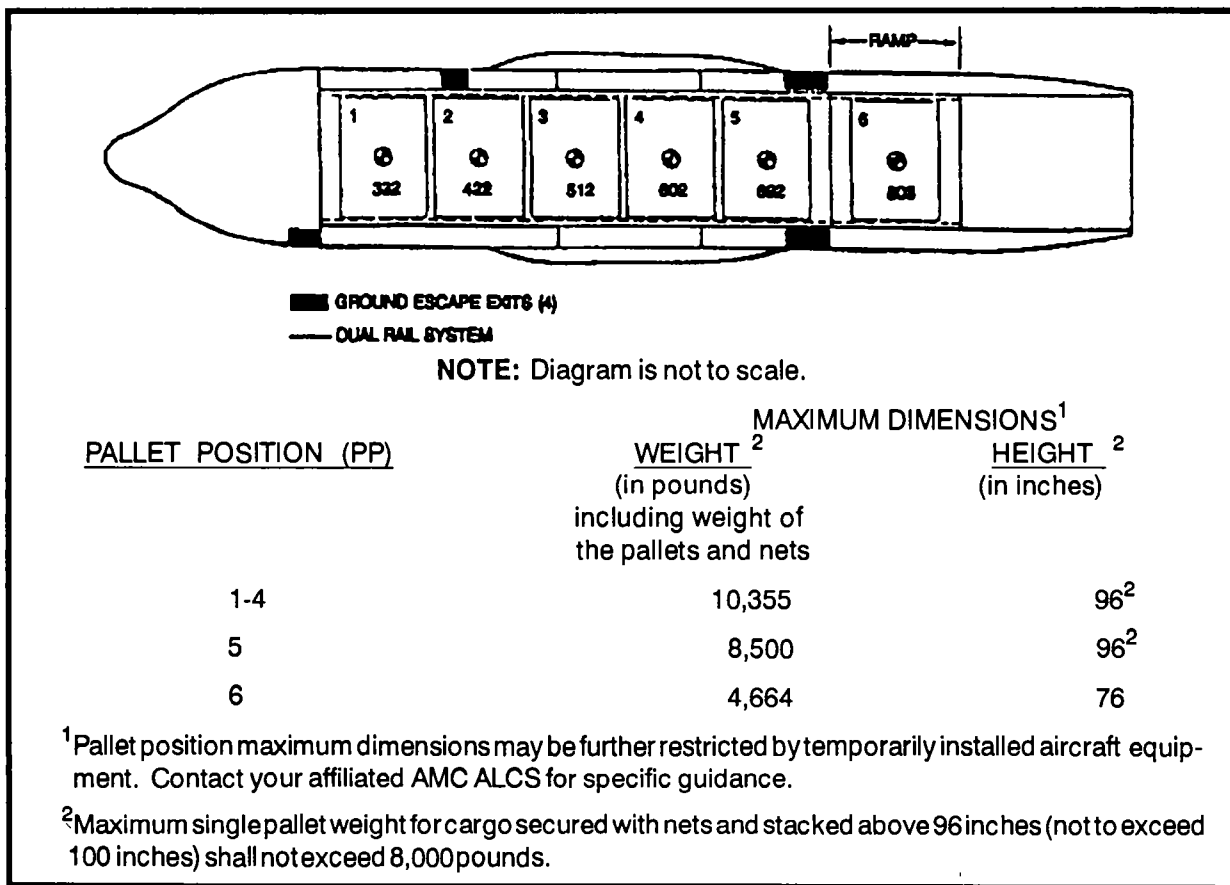
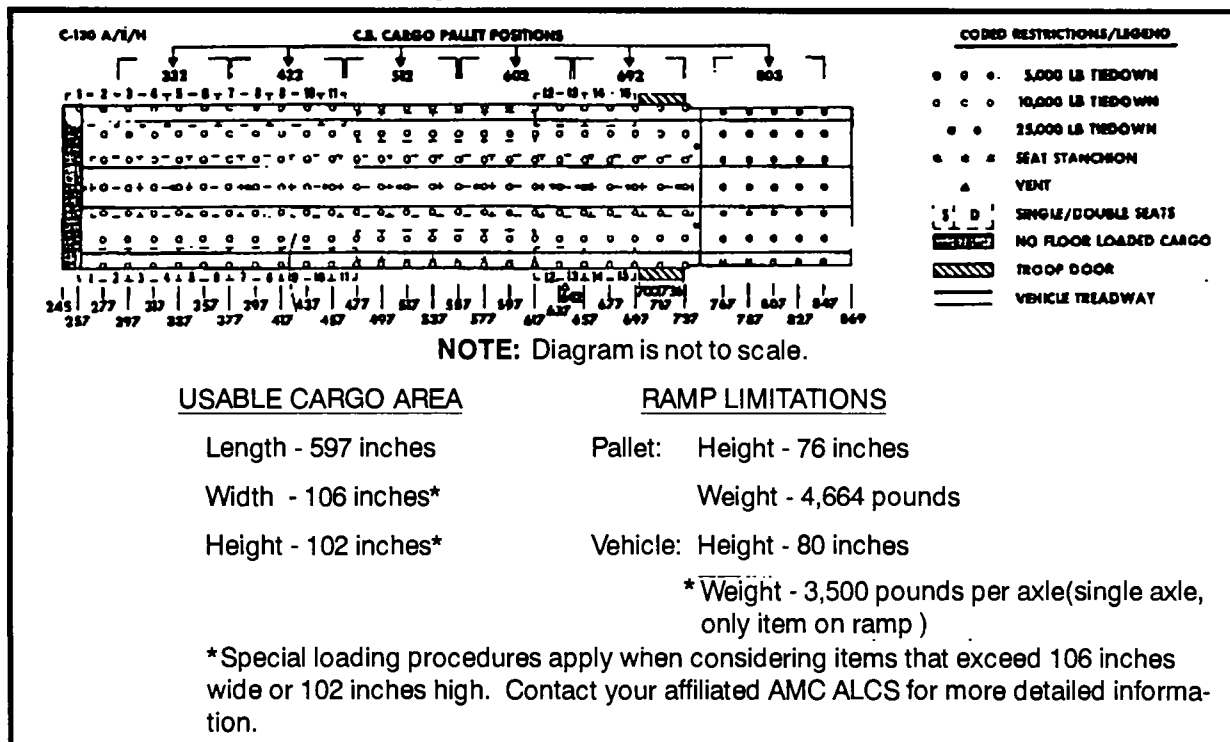
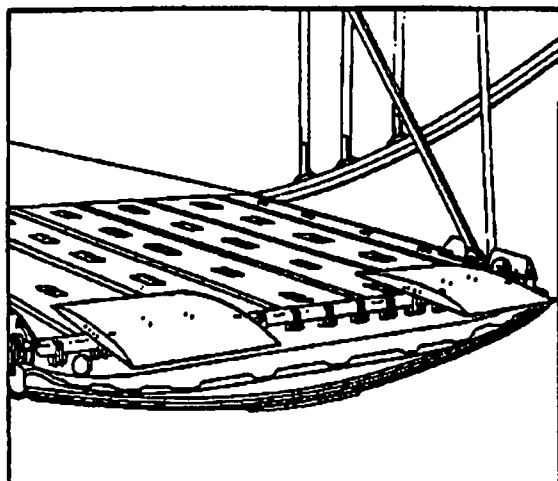


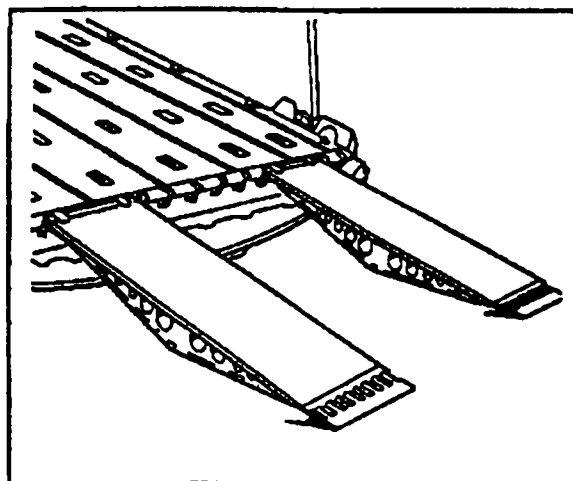
Figure 2-2. C-130 Pallet Positions.



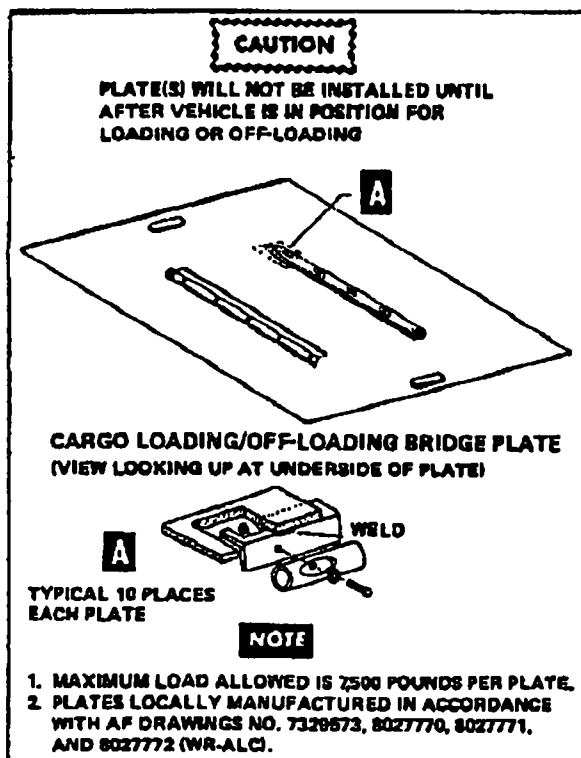
* Figure 2-3. C-130 Schematic.



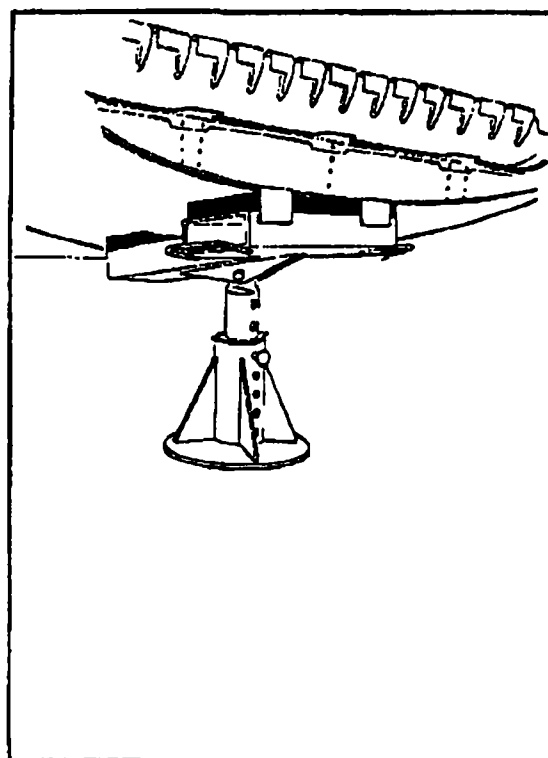
Auxiliary Truck Loading Ramps Installed



Auxiliary Ground-Loading Ramp Installed



Steel Bridge Plate



Ramp Support

Figure 2-4. C-130 Loading Aids.

Rolling Stock Restrictions. Whenever possible, plan to load rolling stock on the treadways of the aircraft as shown in Figure 2-5. Vehicles with pneumatic tires must have a minimum space of 48 inches between axles. If this space cannot be obtained, the axles are considered as a single axle. When load planning and actual loading, the single axle limitations apply (Figure 2-5). Vehicles whose operational height exceeds 102 inches must be reduced in height unless certified to be shipped at a higher height according to TB 55-46-1 or the aircraft loading manual.

When the load consists of palletized cargo or floor-loaded cargo secured with cargo straps, maintain a 30-inch space between the cargo and the nearest forward occupied seat. When cargo is secured with chains, the 30-inch rule does not apply.

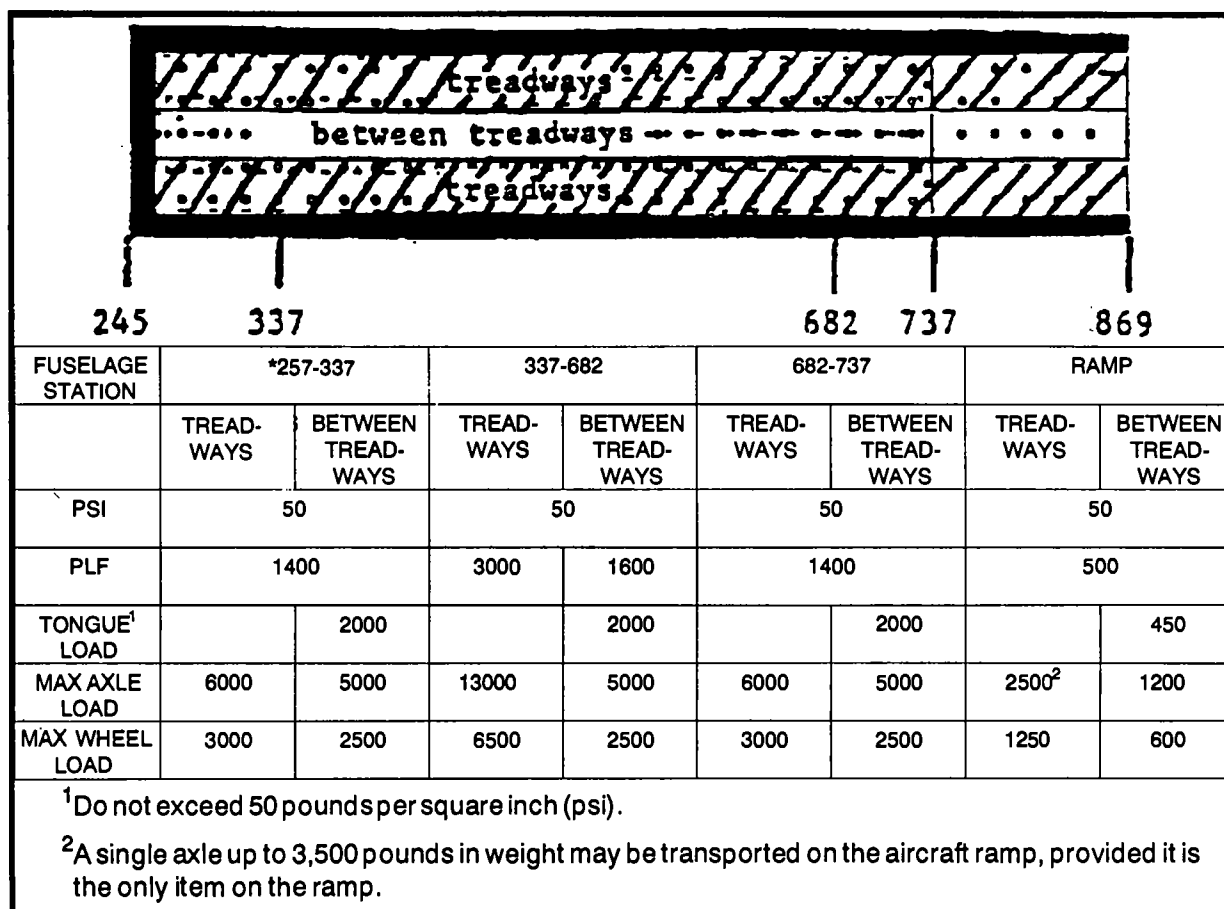
Do not exceed the following limitations:

- Pounds per square inch.
- Pounds per linear foot (PLF).
- Axle weight.
- Wheel weight.

Tracked Vehicle Loading. Figure 2-6 shows an M577 tracked vehicle loaded aboard a C-130 aircraft. The following example is the method to determine loadability and placement on the aircraft floor.

EXAMPLE:

A tracked vehicle is to be loaded aboard a C-130. The tracked vehicle weighs 22,000 pounds. The weight-bearing area of the tracks is 8 feet long (the length of track that contacts the cargo floor in longitudinal plane).



* Figure 2-5. C-130 Flight Limitations Chart.

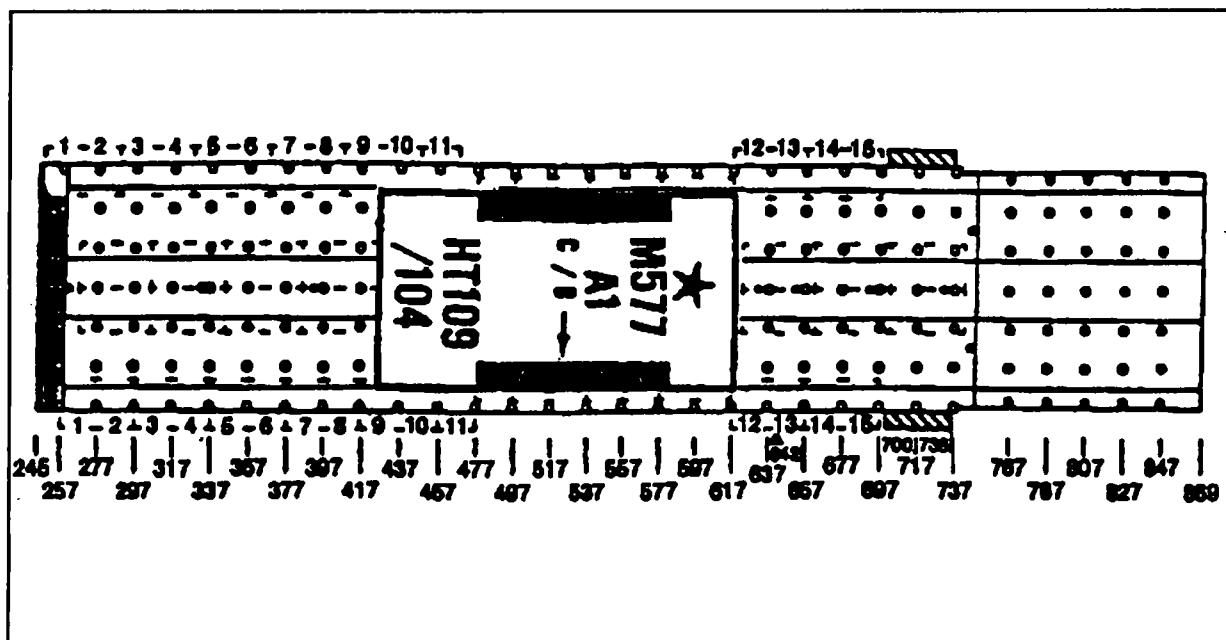


Figure 2-6. Tracked Vehicle on C-130.

To determine the pounds per linear feet, divide the weight of the vehicle by the contact portion of the track. The answer is the amount of PLF being created.

$$\frac{22,000 \text{ pounds (weight of vehicle)}}{8 \text{ feet (floor contact area of track)}} = 2,750 \text{ pounds PLF}$$

The vehicle creates 2,750 PLF. It can be safely transported, but it must be loaded between fuselage stations 337 to 682 (area where tracks must contact the aircraft floor). Allowable limit in this area is 3,000 PLF on the treadways.

Helicopter Loading. Helicopters with major disassembly can be airlifted. Table 2-3 provides data for use in mission planning (for specific guidance, refer to T.O. 1C-130A-9):

C-141 Characteristics

The C-141, nicknamed Starlifter, is a high-wing, heavy transport airplane with four turbofan engines (Figure 2-7). Its mission is to transport unit personnel, equipment, and materiel worldwide. The C-141 is the backbone of the strategic airlift capability of the US Air Force. It is most likely the aircraft to be used for all basic movement planning.

Table 2-3. C-130 Helicopter Loading Data.

<u>TYPE/MODEL</u>	<u>LOADING METHOD</u>	<u>TOTAL UNITS</u>
AH-1	Major Disassembly	1
UH-1H	Major Disassembly	1
OH-58	Major Disassembly	3
LCH-58	Major Disassembly	2
OH-6	Major Disassembly	3

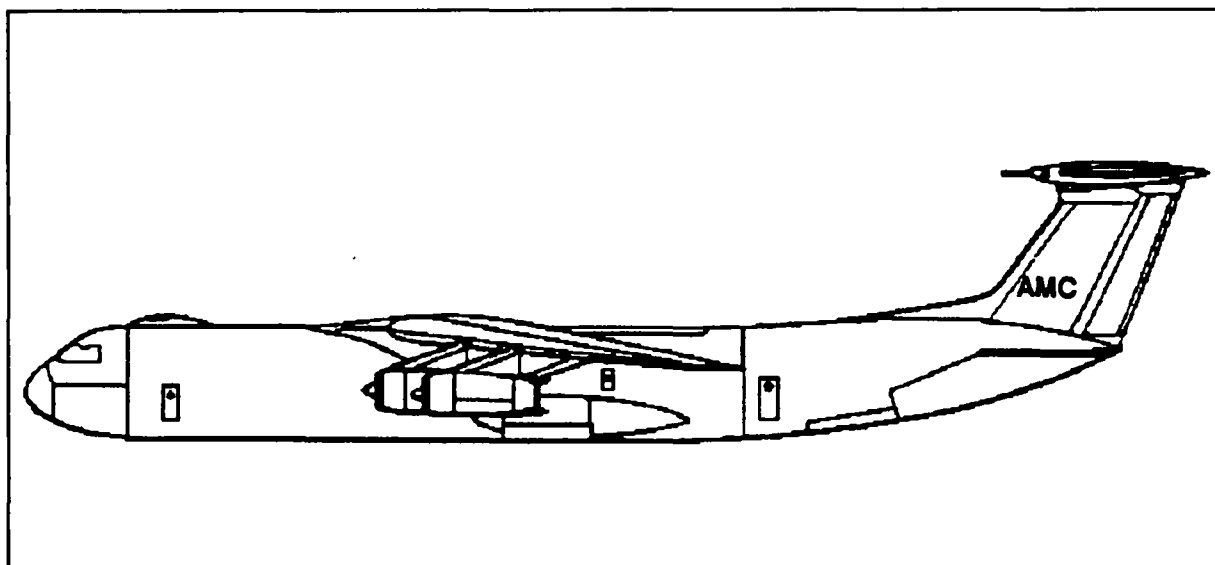


Figure 2-7. C-141 Aircraft.

Passenger Considerations. Like the C-130, the C-141 does not have a separate passenger compartment. For planning purposes, estimate each passenger to weigh 210 pounds. This weight may vary with type of mission (refer to FM 55-12) and should be confirmed with AMC as early as possible. When using side-facing seats, plan for a maximum of 98 passengers. The C-141 will carry a maximum of 200 passengers (160 including flight crew for over water flights).

NOTE: All side-facing seats *except* number 1 left and right must be installed in pairs. Seat number 1 will not stand alone.

Palletized Cargo Restrictions. The C-141 can accommodate up to 13 463L pallets. Pallet position criteria according to position, weight, and height are in Figure 2-8.

Loading Guidance. The cargo area dimensions in Figure 2-9 are for general planning purposes only. Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual. The schematic in Figure 2-9, extracted from DD Form 2130-3 (C-141B Cargo Manifest), shows the fuselage station numbers and pallet position center of balances.

*To more conveniently load the C-141, a number of aids come with the aircraft or are available as options from the supporting AMC TALCE or

aerial port. With the exception of the ramp support, the C-141 aircraft has the same type of equipment listed Figure 2-4 for the C-130 aircraft.

Rolling Stock Restrictions. Whenever possible, plan to load wheeled and tracked vehicles on the treadways. Vehicles whose operational height exceeds 102 inches must be reduced in height unless certified to be shipped at a higher height according to TB 55-46-1 or the aircraft loading manual.

Do not load cargo that touches the floor or overhangs between fuselage stations 292 and 322. Do not stow any wheel loads outboard of the treadways next to the troop doors. The total combined loaded cargo weight between fuselage stations 322 and 678 will not exceed 45,000 pounds. Cargo loaded on the ramp for flight will not have the CB of cargo positioned aft of fuselage station 1473. When the load consists of palletized cargo or floor-loaded cargo secured with cargo straps, maintain a 30-inch space between the cargo and the nearest forward occupied seat. When cargo is secured with chains, the 30-inch rule does not apply. The part of a vehicle that is loaded under the crew rest facility (fuselage stations 322 to 378) will not exceed 80 inches in height measured from the aircraft floor. Do not exceed the limitations in Figure 2-10.

To determine aftmost axle location, use the following procedures (Figure 2-11):

Tracked Vehicle Loading. When planning air movement, there are two types of tracked vehicles: combat vehicles and construction vehicles. The basic difference is the rubber pad protection on the tracks that prevents damage to the ramp and the aircraft floor.

*All vehicles with metal tracks, cleats, studs, or other gripping devices that will damage the floor require rolling and parking shoring (see Chapter 6). For construction vehicles with cleats, the minimum thickness for rolling and parking shoring is 3/4 inch. Planking must be thick enough for cleats or lugs to sink into and for distribution of the load so as not to exceed aircraft limitations. Tracked vehicles with serviceable rubber pads do not require shoring if the aircraft floor limitations are not exceeded. Rubber pads must protrude beyond the steel track so that no portion of the metal track contacts the cargo floor.

Combat vehicles. Tracked combat vehicles have rubber pads on the individual track segments. Generally, they are limited to a maximum practical

gross weight of 44,00 pounds. More specific limits are as follows:

MAXIMUM AXLE WEIGHT (in pounds)	MINIMUM REQUIRED SHORING
5,000	3/4 inch
5,001 to 5,500	1 inch
5,501 to 6,500	1 1/2 inch
6,501 to 7,900	2 inch
7,901 to 10,000	3 inch

Approximate axle weights for vehicles with five axles or less by dividing the gross vehicle weight (GVW) by the number of axles minus 0.5. For example, the weight of a vehicle with five axles would be divided by 4.5.

Approximate axle weights for vehicles with six or more axles by dividing the gross vehicle weight by the number of axles minus 1.0. For example, the weight of a vehicle with seven axles would be divided by six.

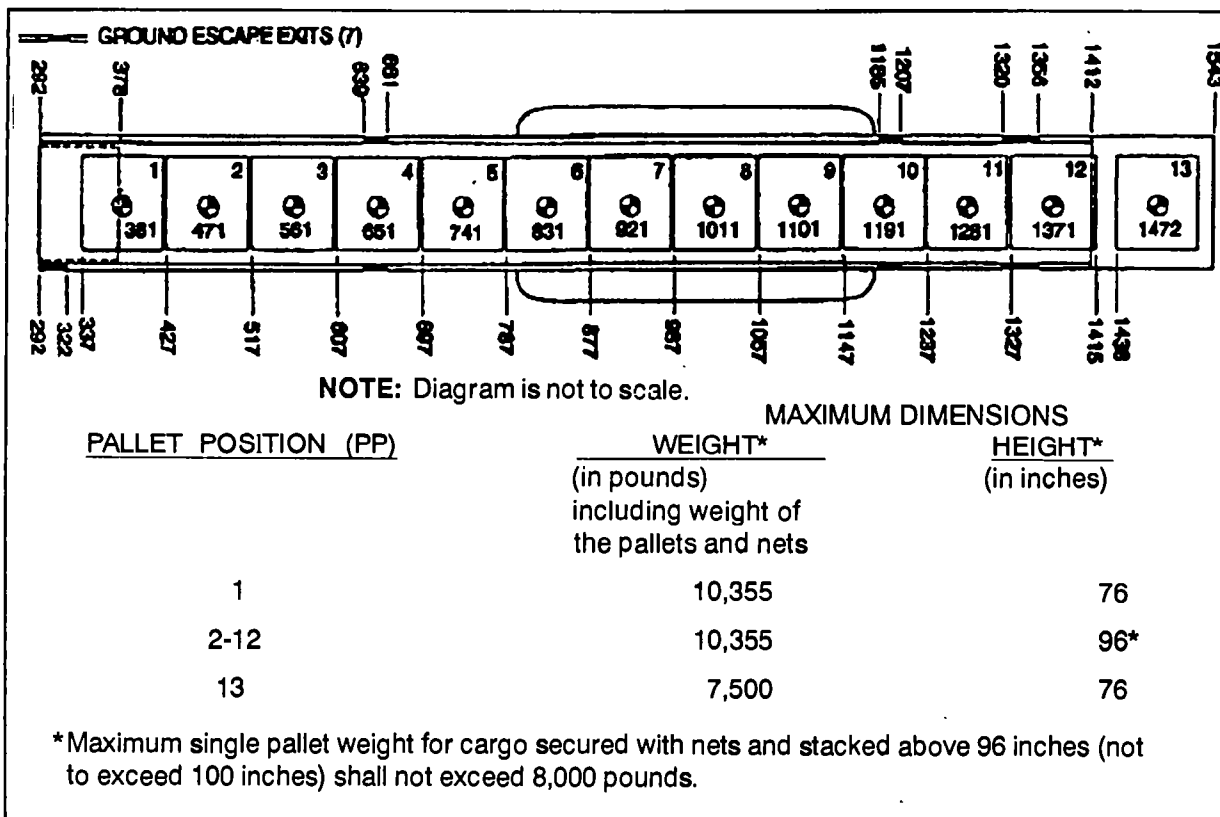
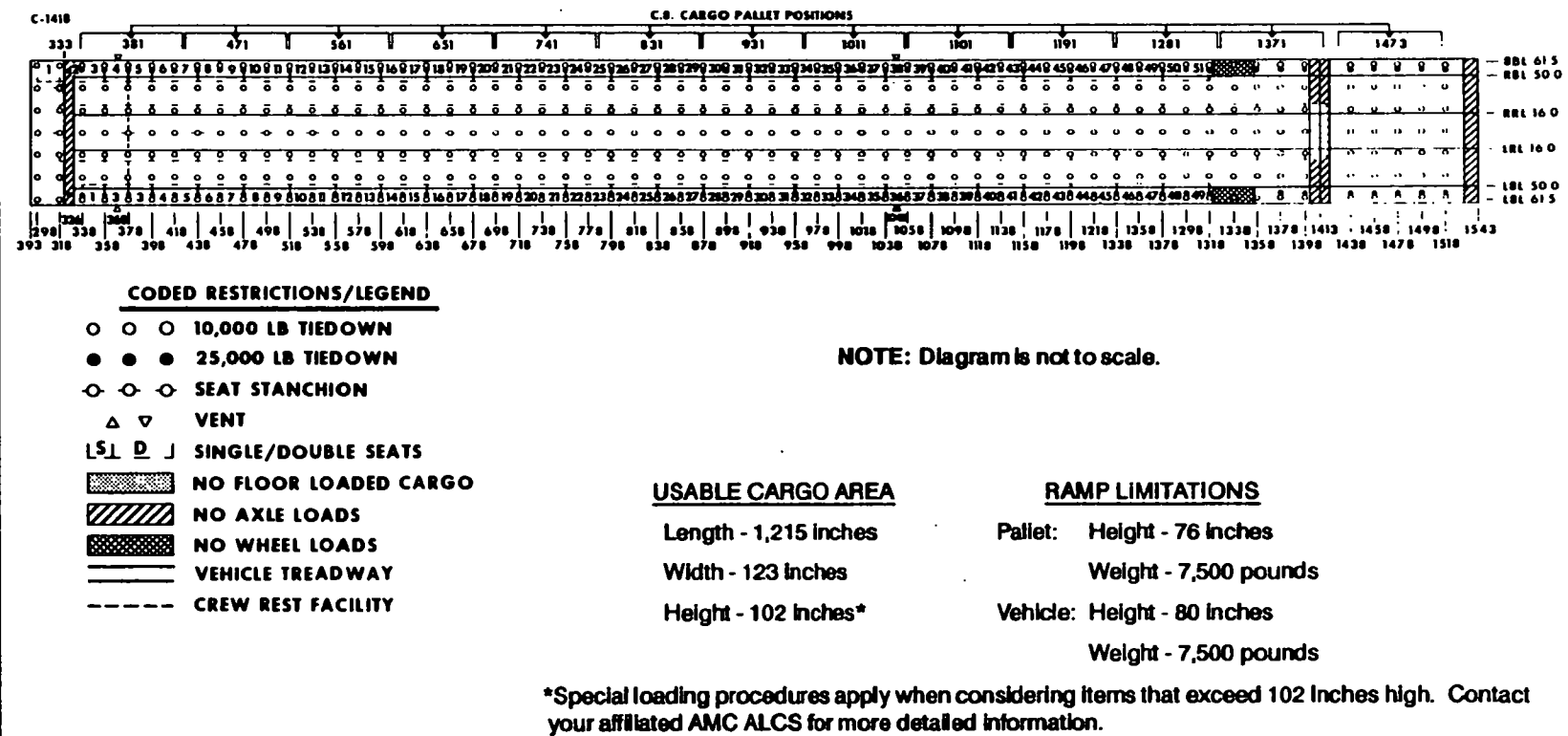


Figure 2-8. C-141 Pallet Positions.

Figure 2-9. C-141 Schematic.



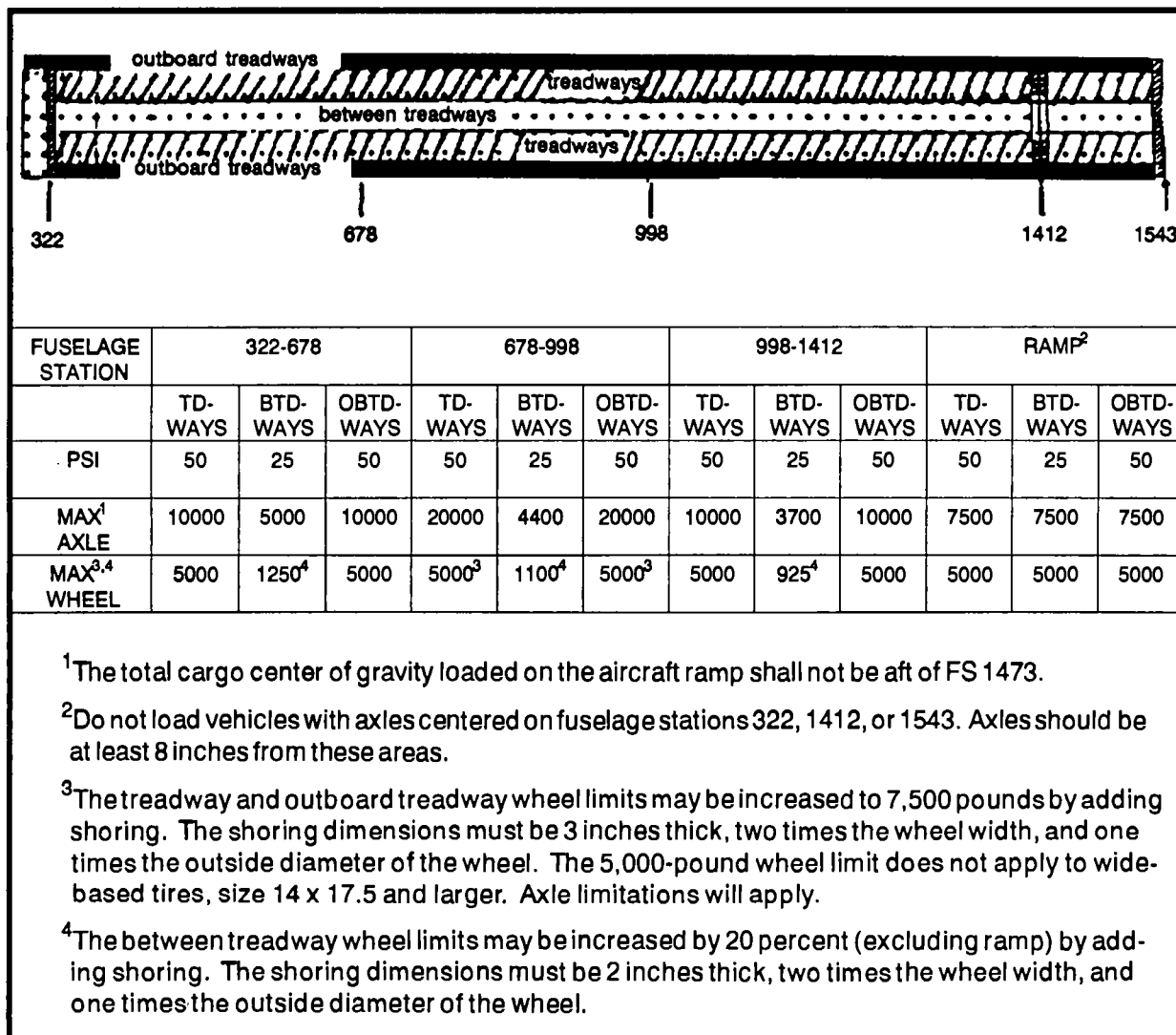


Figure 2-10. C-141B Flight Limitations Chart.

*The following example shows how to determine the maximum axle weight for a tracked vehicle.

EXAMPLE:

Gross vehicle weight = 28,950 pounds

Number of axles = 5

$$5 \text{ axles or less} = \frac{\text{GVW}}{\text{number of axles} - 5} = \frac{28,950}{4.5} = 6,434$$

Computed load per axle = 6,434 pounds

1 1/2 inches of shoring is required.

*Construction vehicles. Tracked construction vehicles usually do not have rubber pads on the

track segments. They are generally limited to a maximum practical gross weight of 44,000 pounds. Tracked vehicles with cleats require rolling and parking shoring. Shoring must be a minimum of 3/4 inch. Vehicles heavier than 32,500 pounds must be loaded straight in from a trailer or K loader. Vehicles that exceed any of these criteria or have unusual suspensions require special analysis and loading and shipping procedures. Load planners should obtain HQ AMC ALCS or affiliated ALCS guidance.

Helicopter Loading. Table 2-4 provides data for use in mission planning. (For specific guidance, refer to T.O. 1C-141B-9.)

Passenger Considerations. The troop compartment is in the upper deck area on the C-5 aircraft. It is a self-contained compartment with a galley, two lavatories, and 73 available passenger seats (CB at FS 1675). An additional 267 airline seats may be installed on the cargo compartment floor (maximum combined total of 329 troops including the aircrew over water).

***Palletized Cargo Restrictions.** The C-5 can accommodate up to 36 463L pallets. Pallet criteria according to position, weight, and height are listed below.

<u>PALLET POSITION</u>	<u>MAXIMUM WEIGHT</u>	<u>MAXIMUM HEIGHT*</u>
1-2*	7,500 pounds	96 inches
3-34	10,355 pounds **	96 inches**
35-36*	7,500 pounds	70 inches

*463L pallets loaded in pallet positions 1, 2, 35, and 36 shall have a 14-inch access aisle that will extend from the outboard edge of the pallet to the vertical stacking line of the cargo.

**Maximum single pallet weight for cargo secured with nets and stacked above 96 inches (not to exceed 100 inches) shall not exceed 8,000 pounds.

Loading Guidance. The cargo area dimensions in Figure 2-13 are for general planning purposes only. The schematic in Figure 2-13, extracted from DD Form 2130-1 (C-5A/B Cargo Manifest), shows the fuselage station numbers and pallet position centers of balance.

The cargo compartment design, dimensions, and payload capability have been optimized to deploy units, personnel, equipment, and materiel. The compartment has a forward cargo door (visor) and ramp and an aft cargo door system and ramp. The visor door, when closed, forms the nose of the aircraft. The forward ramp extension is stowed in the vertical position. The aft pressure door, also used as a ramp extension, may be raised to a horizontal position to permit airdrop operations.

For general cargo and vehicular tie-down provisions, the cargo floor of the C-5 has 304 flush, permanently installed rings. Each ring can sustain a design limit load of 25,000 pounds. The tie-down rings are designed to receive either one hook from

a 25,000-pound restraint device or two hooks from 10,000-pound restraint devices.

Another feature that facilitates and expedites loading and unloading operations is the kneeling capability. Kneeling the landing gear permits the cargo compartment floor to be lowered approximately 10 feet to about 3 feet above the ground. This kneeling feature was incorporated for two reasons: to facilitate loading operations by lowering the cargo ramps for truck-bed and ground loading and to reduce the ramp angles for loading and unloading vehicles.

Figure 2-14 shows the cargo floor and ramp angles for the kneeling condition. It also shows the C-5 nose up when aft-kneeled, nose down when forward-kneeled, and level when level-kneeled.

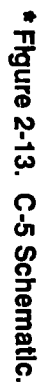
Note the dimensional data provided with the aircraft sections shown in Figure 2-15. The diagrams depict the front of the C-5 facing aft.

Figure 2-16 shows the details of the forward cargo opening with the visor in the raised position. The side profile of the cargo floor shows the ramp in the ground loading position in the stowed position. The front view of the cargo opening shows detailed dimensions of the opening.

To ground load or unload vehicles, the pressure door is hinged to the ramp as a ramp extension and lowered to contact the ground. Figure 2-17 shows the aft cargo ramp in the ground loading position.

Rolling Stock Restrictions. The cargo floor is a load-carrying structure across its whole width. Vehicles can traverse its whole area and maneuver freely during loading operations. In flight, single 36,000-pound axle loads or a combination of axles weighing up to 36,000 pounds may be carried on any continuous 40-inch longitudinal length of cargo floor area between fuselage stations 724 and 1884. Figure 2-18 also shows the in-flight loading limits on other floor areas and on the ramps. The capability of the ramps and floor are such that tanks and other tracked vehicles weighing up to 129,000 pounds can be loaded and transported.

Helicopter Loading. Table 2-5 provided data for use in mission planning. For specific guidance, refer to T.O. 1C-5A-9):



USABLE CARGO AREA

Width - 228 inches

Height - 156 inches

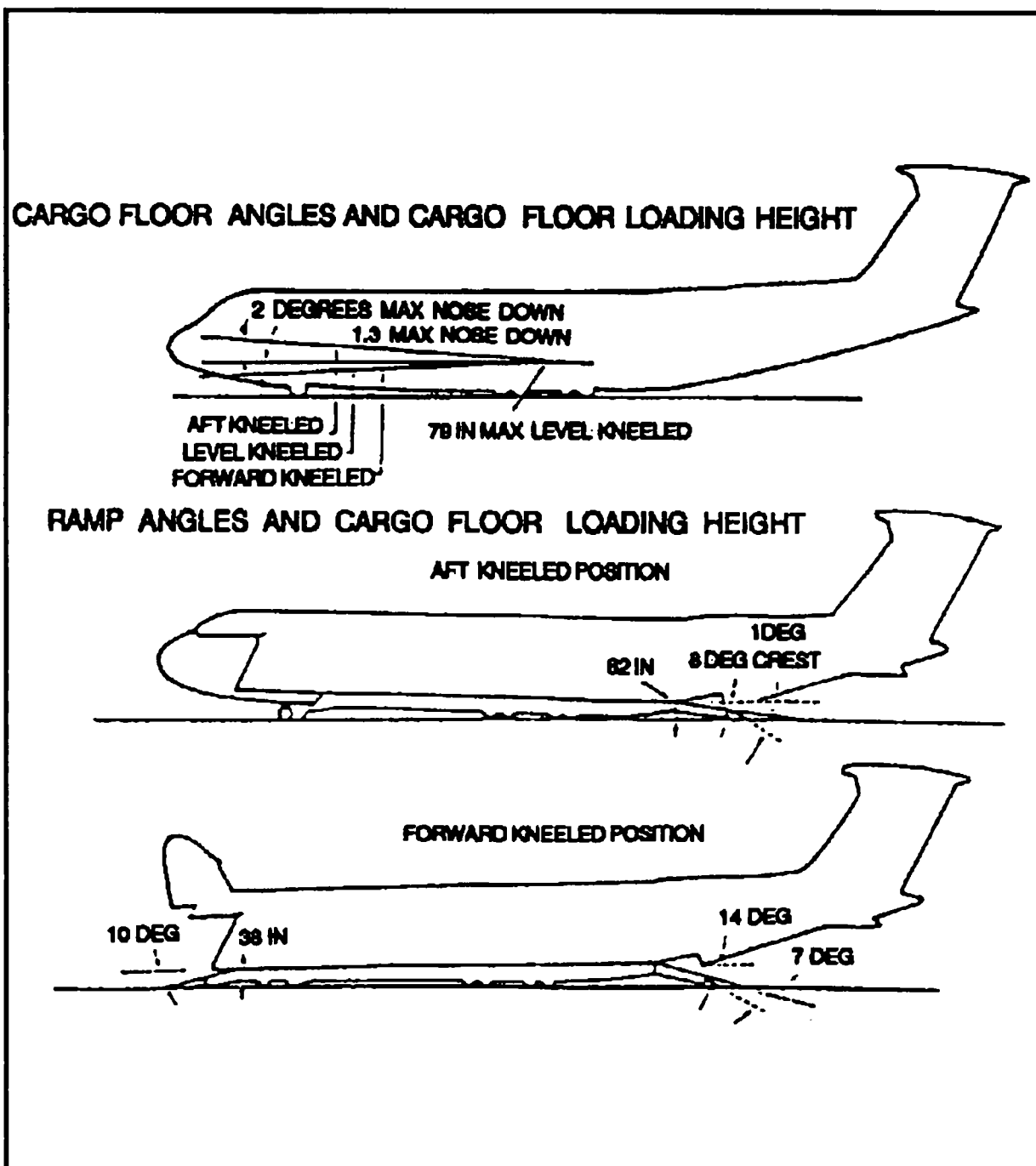


Figure 2-14. Cargo Floor Angles and Loading Height.

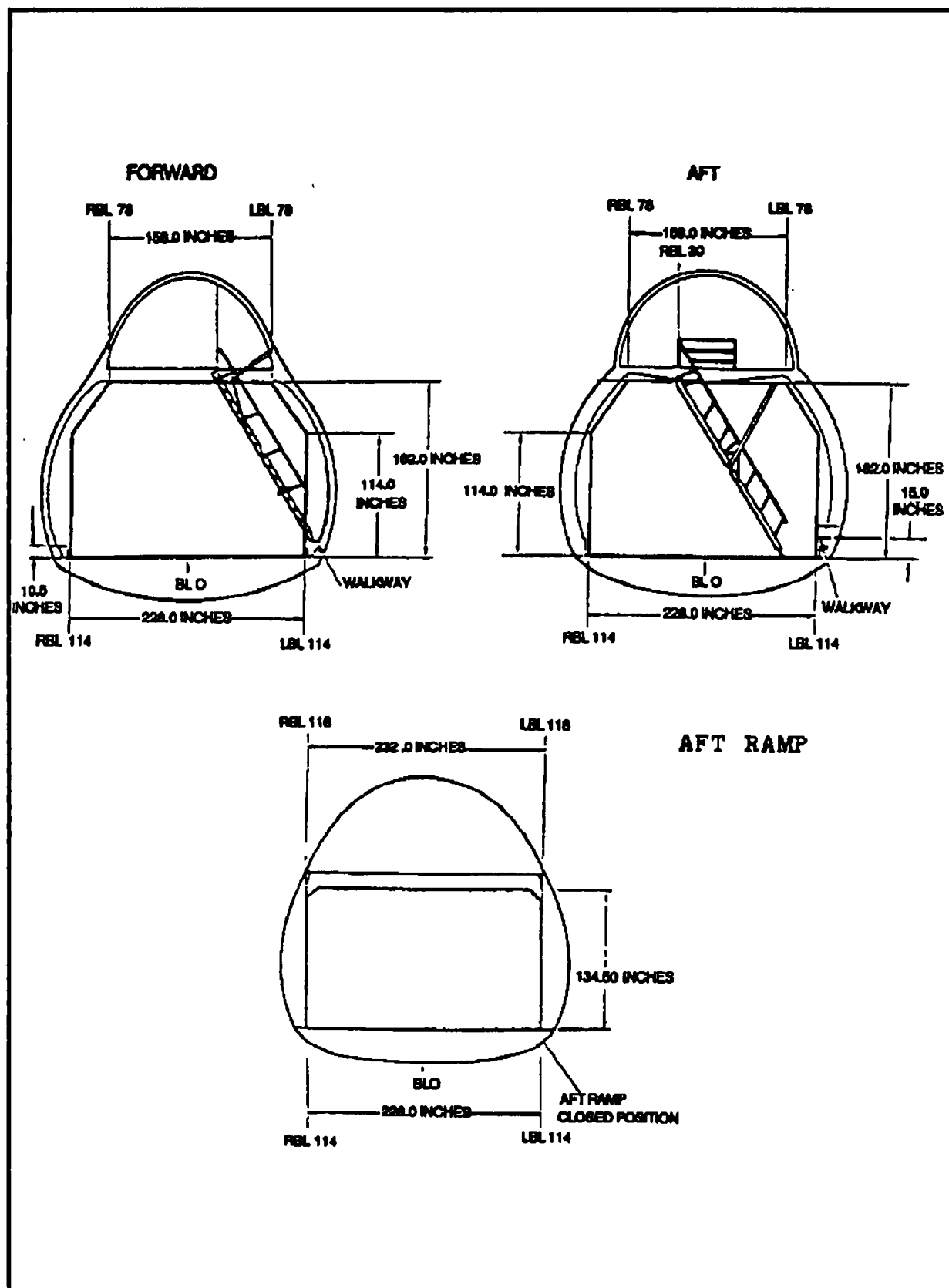


Figure 2-15. C-5 Cargo Compartment Dimensions.

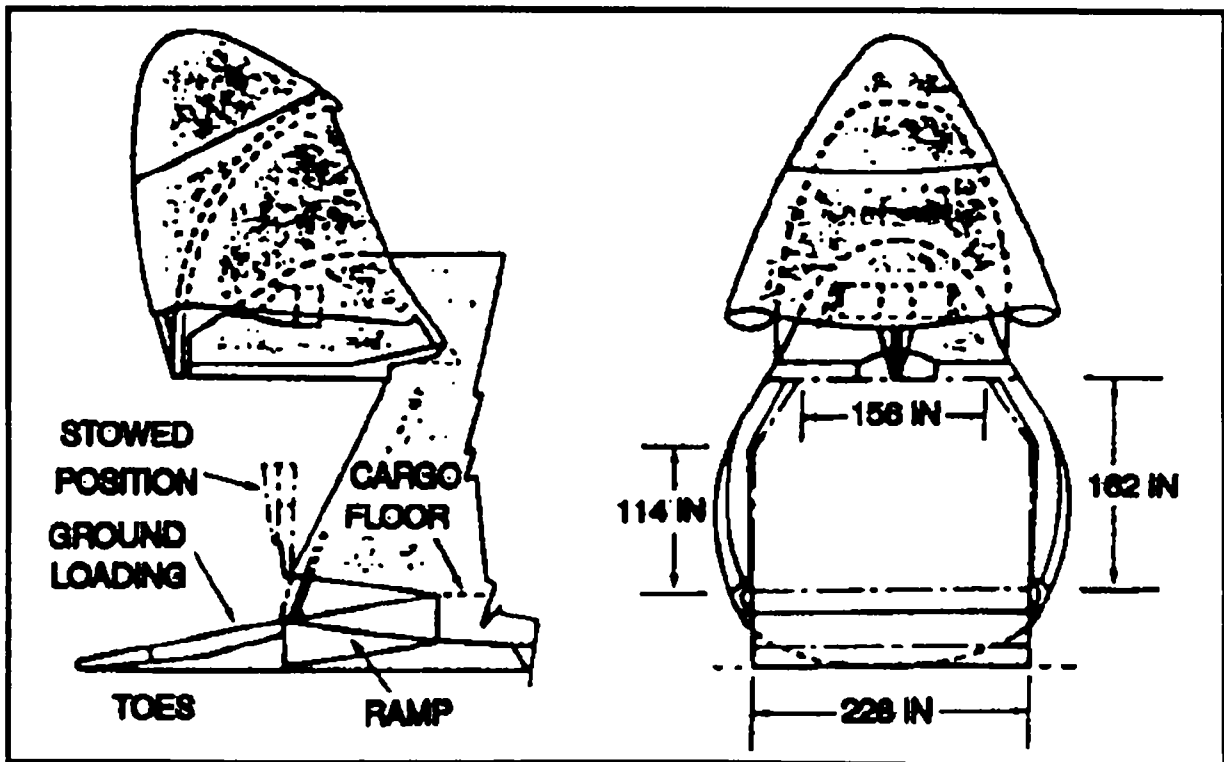


Figure 2-16. C-5 Visor Raised Position.

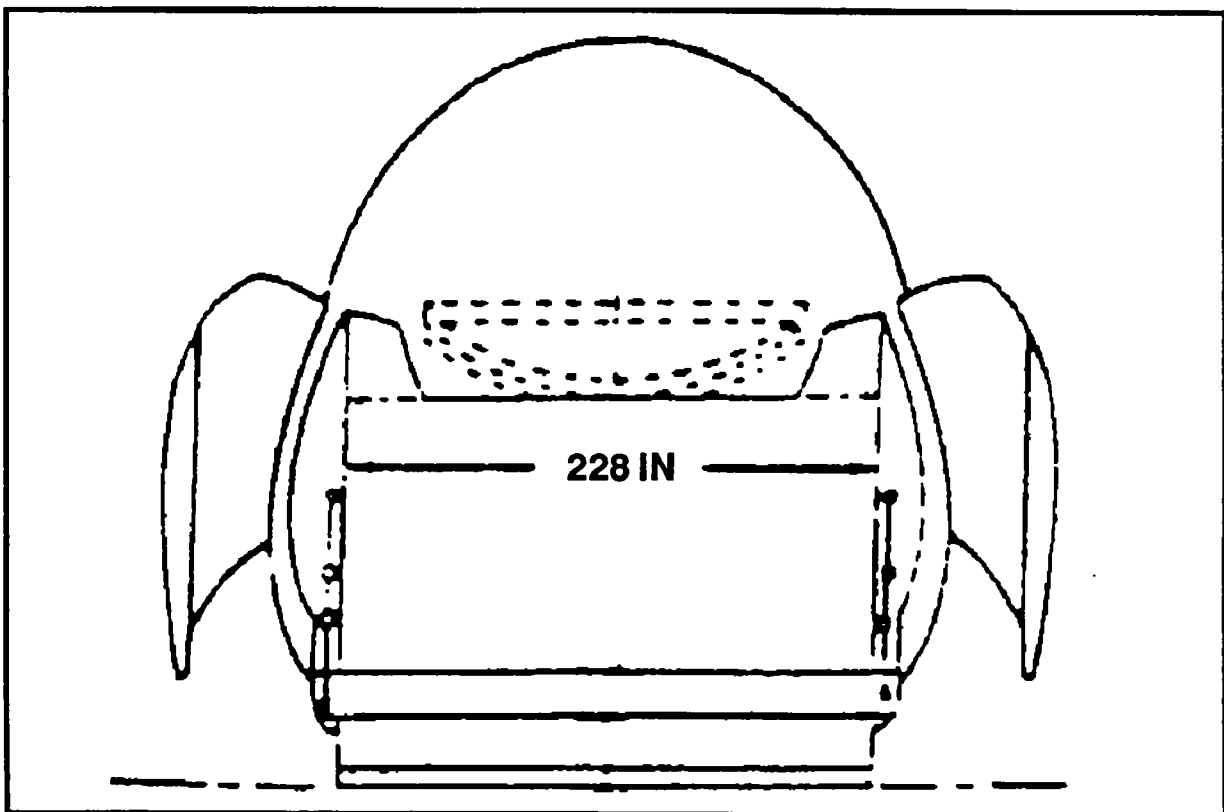


Figure 2-17. Ground Loading - Aft Cargo Ramp.

Figure 2-18. C-5 Flight Limitations Chart.

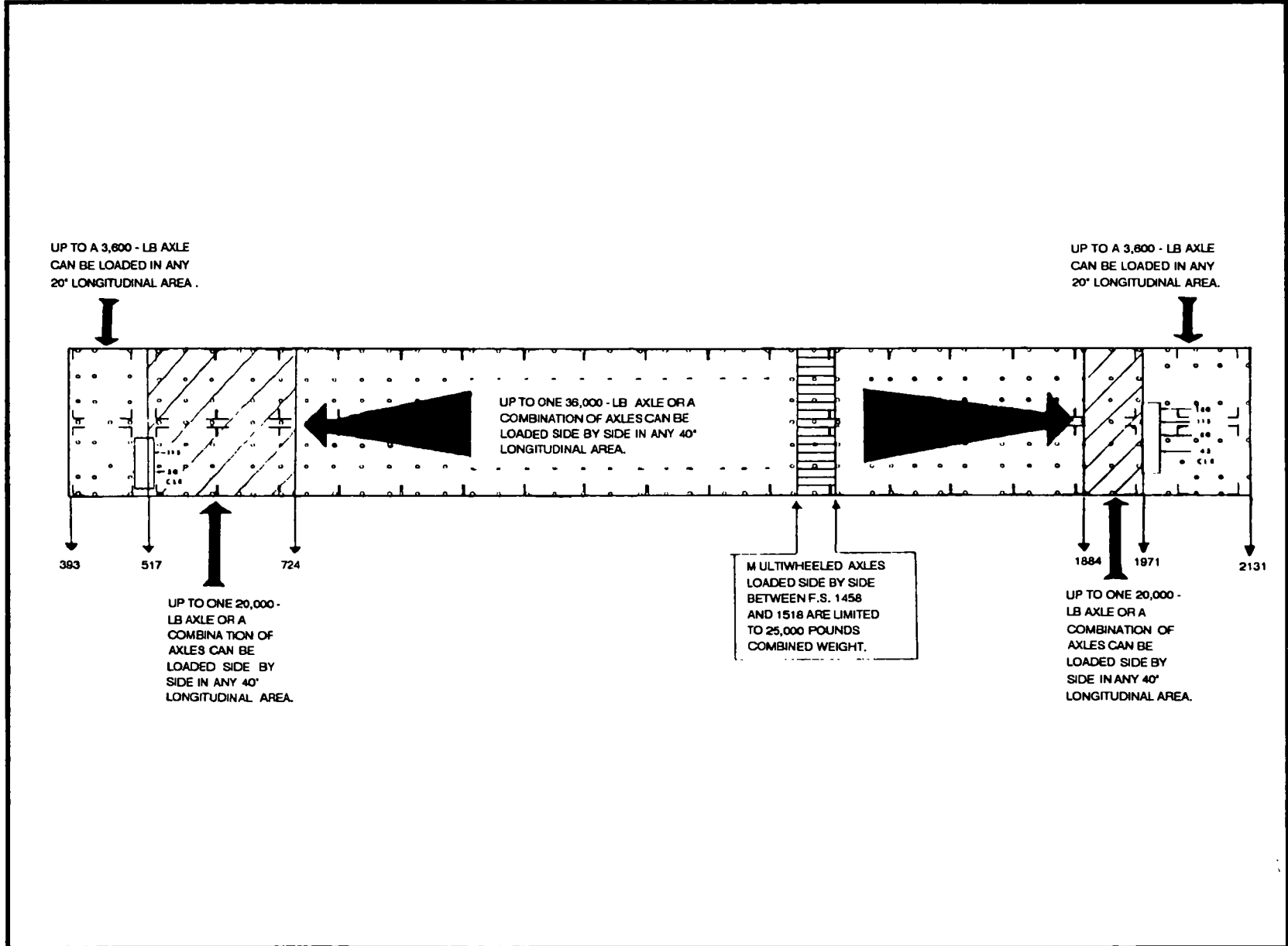


Table 2-5. C-5 Helicopter Loading Data.

<u>TYPE/MODEL</u>	<u>LOADING METHOD</u>	<u>TOTAL UNITS</u>
AH-1 Wings Removed	Disassembled	12
AH-1S Wings Installed	Assembled/Minimum Disassembly	5/7
UH-1	Minimum Disassembly	7/8
UH-1	Disassembled	11
OH-6A	Assembled	26
CH-46	Disassembled	3
CH-47 Load thru Aft Doors	Disassembled	2
CH-47 Load thru Fwd Doors	Disassembled	3
CH-54	Disassembled	2
OH-58	Minimum Disassembly	13
OH-58	Disassembled	22
UH-60	Minimum Disassembly	6
AH-64	Minimum Disassembly	6

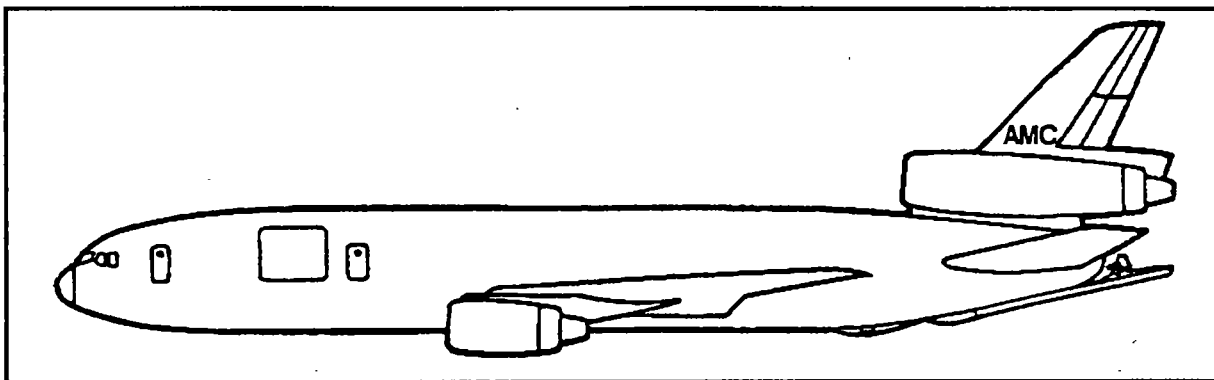


Figure 2-19. KC-10 Aircraft.

KC-10 Characteristics

The KC-10, nicknamed Extender, is a swept-wing, wide-body tri-jet with a dual-purpose mission as an aerial refueler and cargo/passenger aircraft (Figure 2-19). Unit personnel, equipment, and materiel are carried on the upper deck, and fuel tanks are contained in the lower compartments of the fuselage.

Passenger Considerations. When planning passenger movement on the KC-10, the limiting factor will be the configuration requested or approved (Appendix A). Planning weightn for passengers will be 180 pounds. The KC-10 may carry up to 69 passengers (69 over water).

***Palletized Cargo Restrictions.** The KC-10 uses a rounded cargo compartment to maximize cargo-carrying capability. It can accommodate up to 27 463L pallets. Normally, a maximum of 25 pallet positions will be authorized. Usable surface dimensions of a pallet are 104 inches long by 84 inches wide. Due to location of pallet restraint rail systems in the KC-10, the 108-inch side becomes the length of the pallet. Pallet criteria according to position, weight, and height are in Figures 2-20 and 2-21.

For ease of planning, the two pallet profiles in Figure 2-22 will simplify pallet build-up. The two pallet profiles are--

- 104 inches long x 84 inches wide x 70 inches high for pallet positions 2 through 10.
- 104 inches long x 65 inches wide x 60 inches high for pallet positions 11 and 12.

These profiles may be exceeded to maximize use of the cargo compartment. However, the maximum profile limits (Figures 2-20 and 2-21) will not be exceeded.

Loading Guidance. The following cargo area dimensions are for general planning purposes only:

USABLE CARGO AREA

Length - 1,416

Width - 218

*Height - 96

NOTE: Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual.

The schematics in Figures 2-23 and 2-24, extracted from DD Forms 2130-6 and 2130-7 (KC-10 cargo manifests), show the fuselage station numbers, seating arrangements, and pallet position centers of balance.

Restraint criteria for other than netted cargo are as follows:

RESTRAINT CRITERIA*

DIRECTION	REQUIREMENT
Forward (with cargo barrier net)	1.5 g's
Forward (without cargo barrier net)	9.0 g's

Aft	1.5 g's
Lateral	1.5 g's
Vertical	2.0 g's

*See Chapter 7, Cargo Restraint.

There is no provision for floor loading unit equipment or passenger baggage. All hand-carried items, such as crew-served weapons, rucksacks, and web belts, must either fit under the airline-style seating or be palletized.

Rolling Stock Restrictions. The unique loading requirements and limitations for the KC-10 require special attention. Any time the use of a KC-10 for airlift is anticipated, arrangements must be made for a wide-body loader at the location. Unlike other AMC aircraft, the KC-10 does not have a ramp at ground level to roll equipment on and off. The cargo door is about 15 feet above ground level. Also, unlike other cargo aircraft, the KC-10 cargo floor cannot withstand the stress of heavy axle floor loading. Therefore, the 463L pallets must be used as a subfloor whenever cargo or baggage is to be loaded aboard this aircraft. Also, because of the location of the cargo door, cargo width and height must be within the cargo door limits (Figure 2-25).

There are three acceptable loading methods for use with the 463L pallet. The actual method used to load equipment depends on numerous variables including allowable loading time and availability of materials-handling equipment (MHE). (Wide-body loaders, K loaders, and forklifts are needed to load and move pallets.) The methods are described as follows:

- The first method is to prepalletize and secure cargo on individual 463L pallets before loading. This method requires the least amount of time for loading.
- The second method is to place empty 463L pallets into the aircraft to create a pallet subfloor. The equipment is then driven or pushed into place and secured for flight.
- The third method uses a combination of the first two methods. The combination method provides the flexibility for last minute changes and requires less use of MHE.

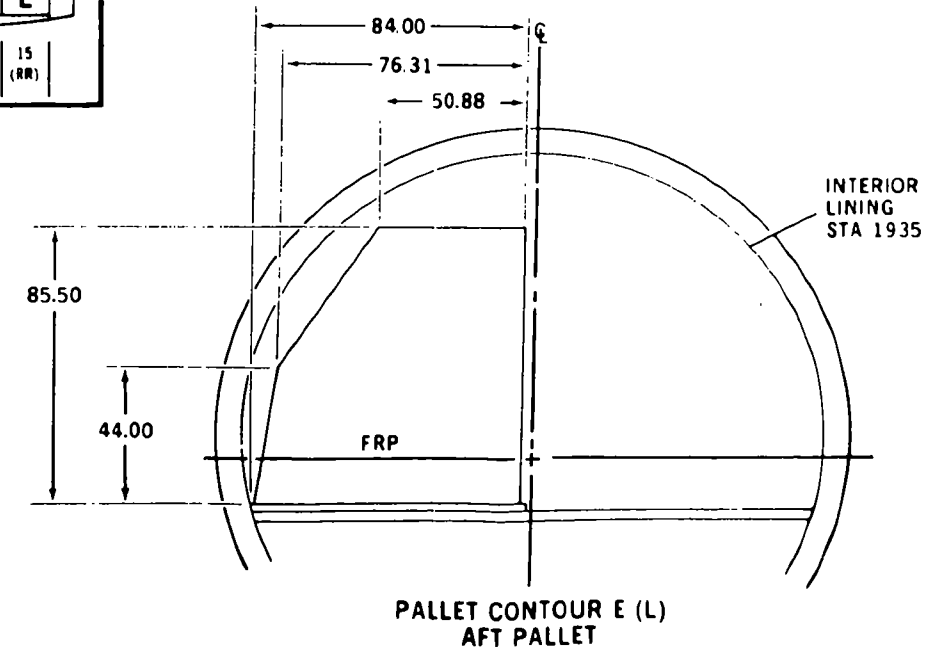
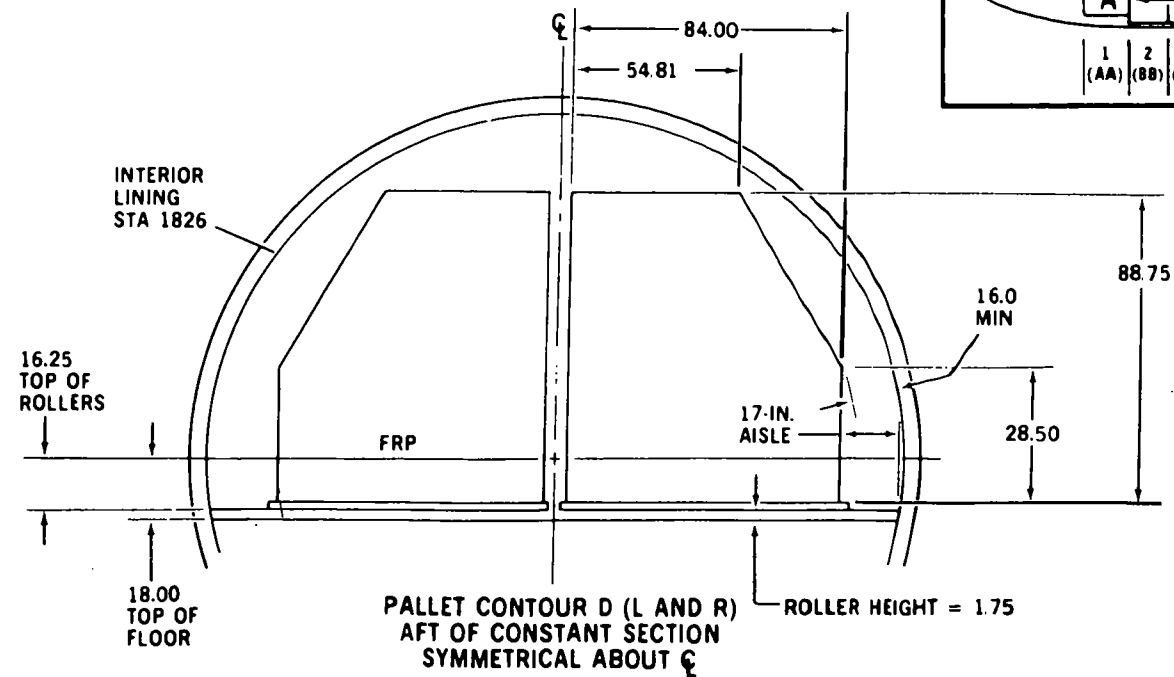
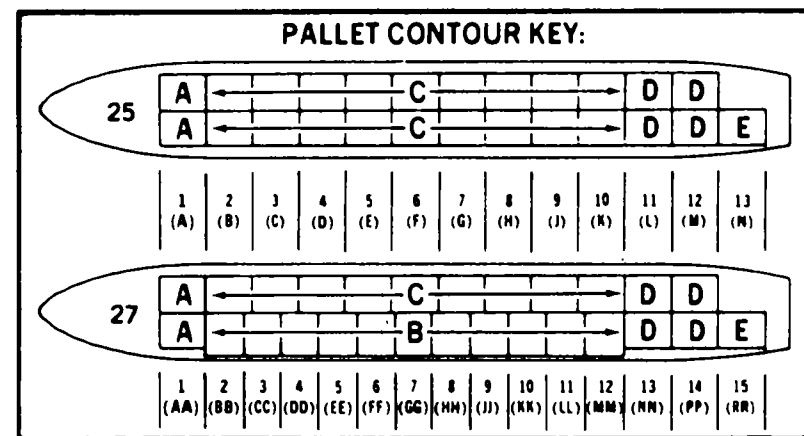
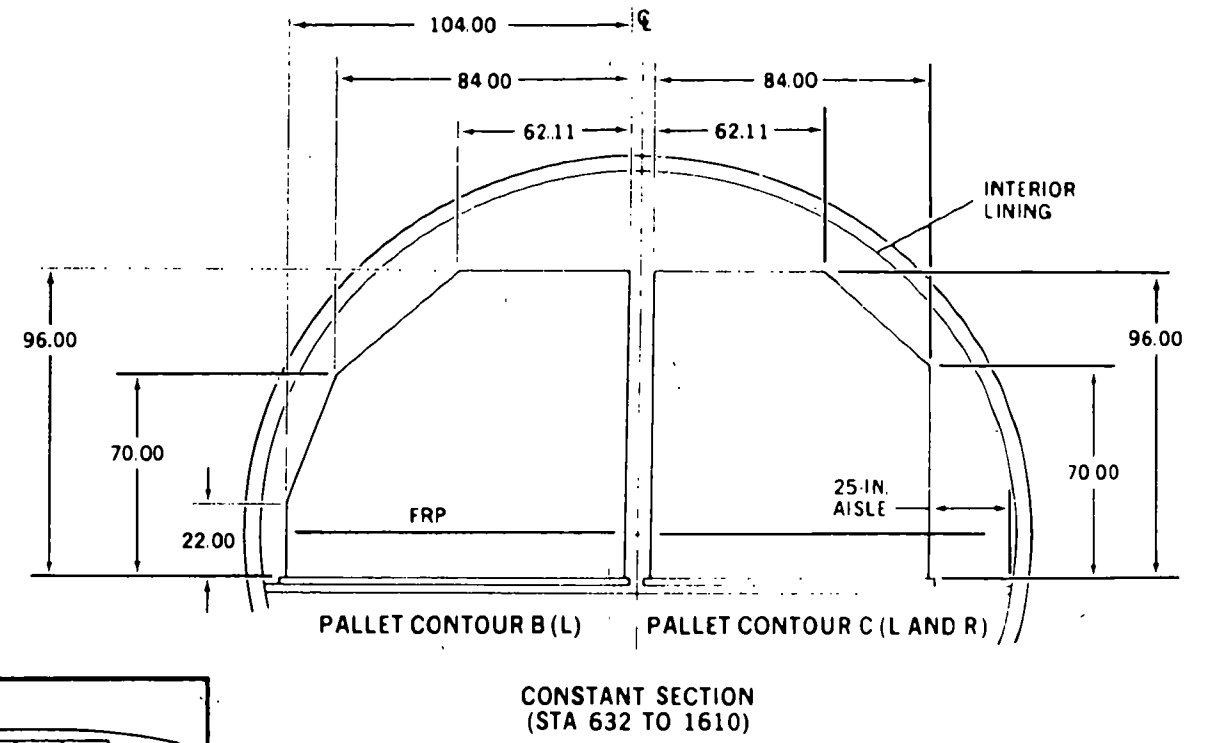
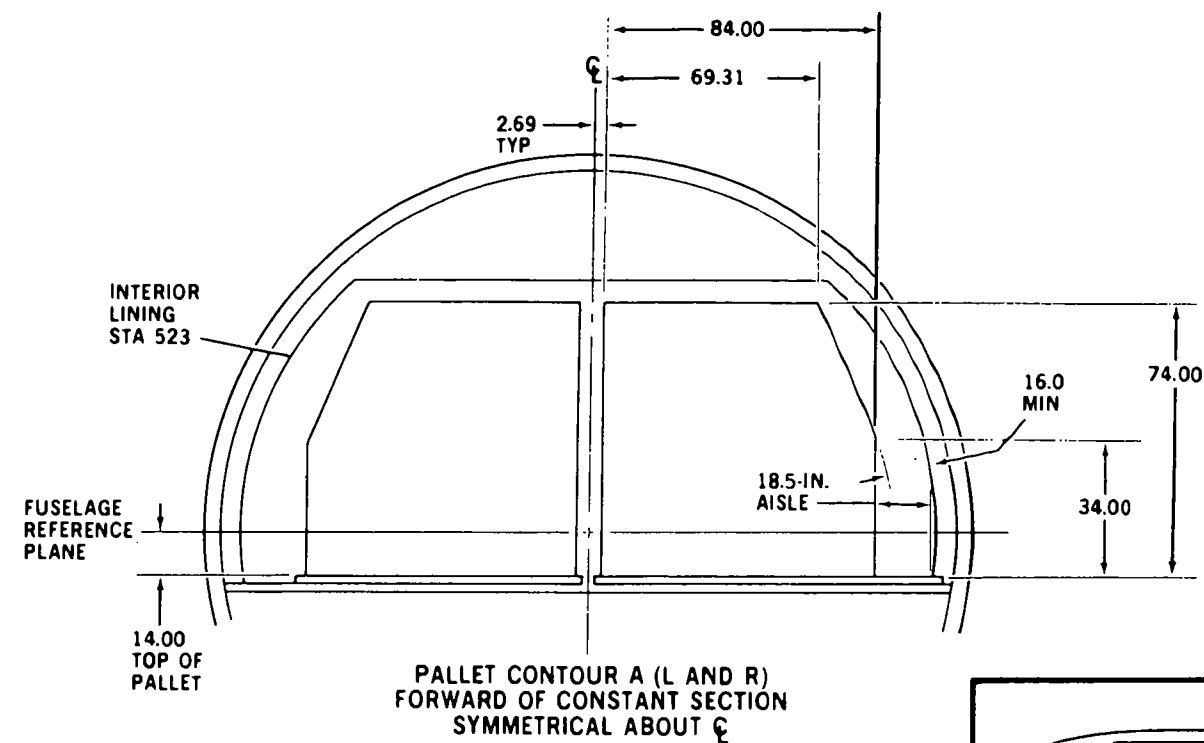
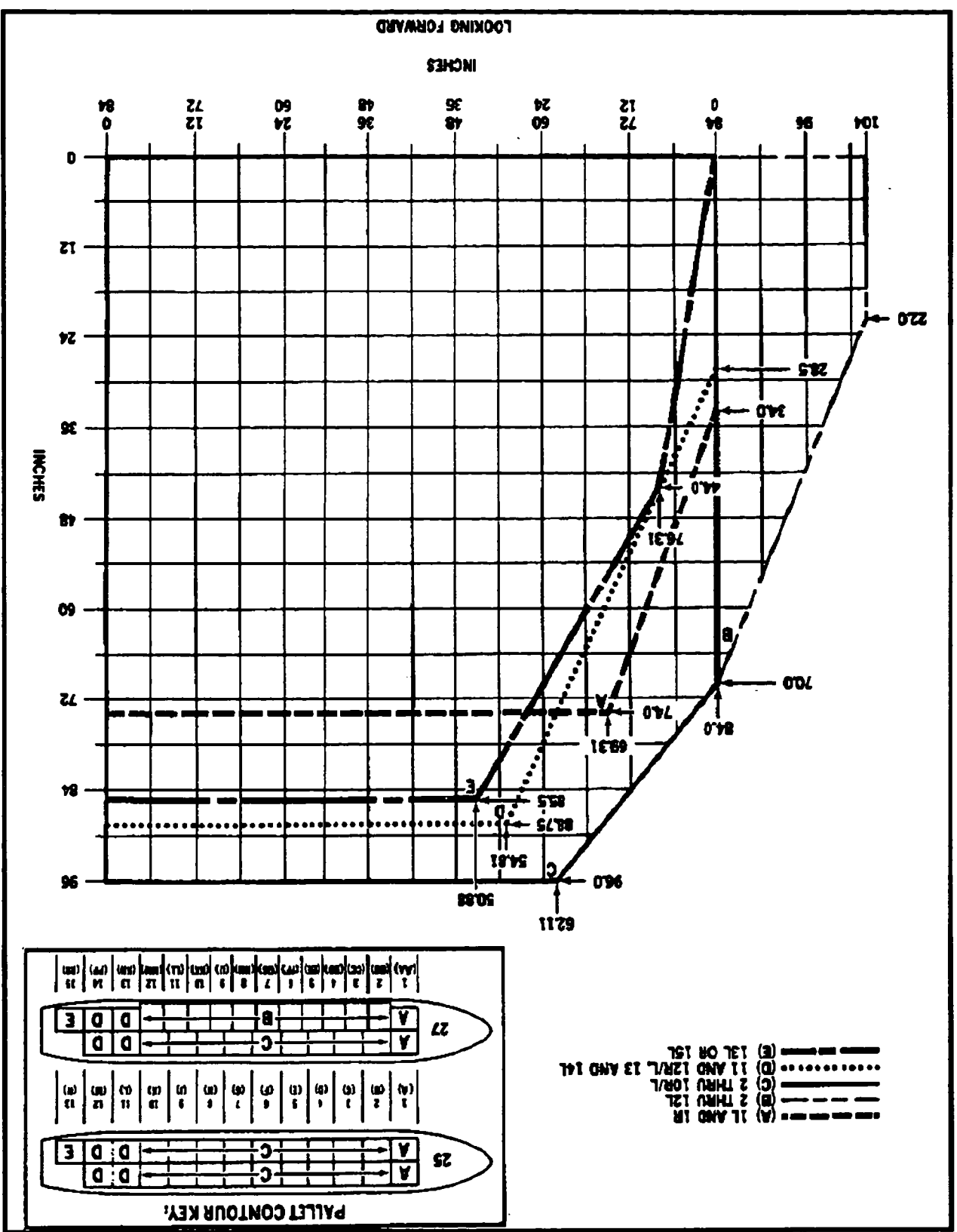


Figure 2-20. Pallet Contours and Aisle Configurations (Sheet 1).

Figure 2-21. Pallet Contours and Aisle Configurations (Sheet 2).



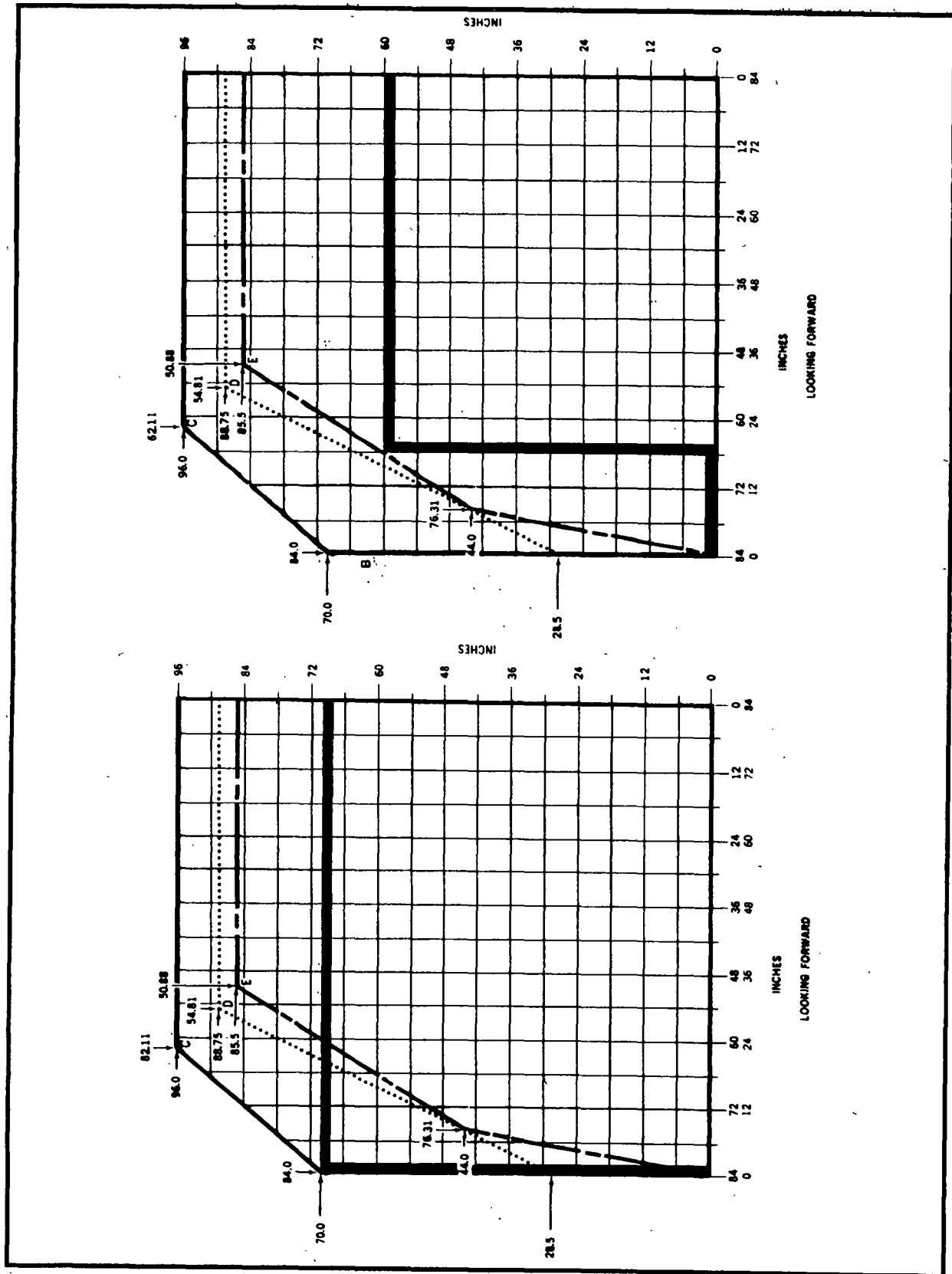


Figure 2-22. Pallet Profiles.

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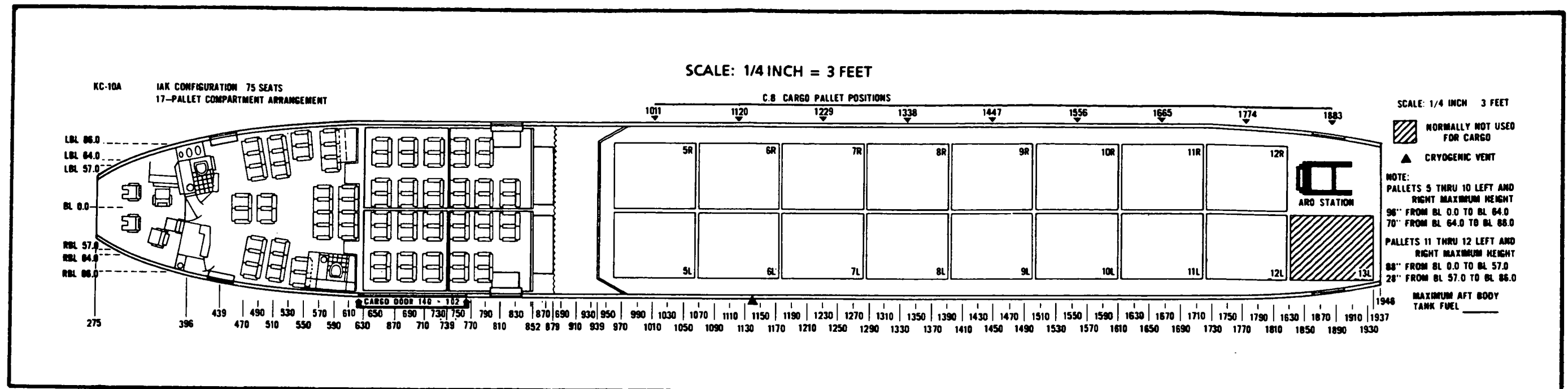


Figure 2-23. KC-10 Schematic—17 Pallets Configuration (Code D).

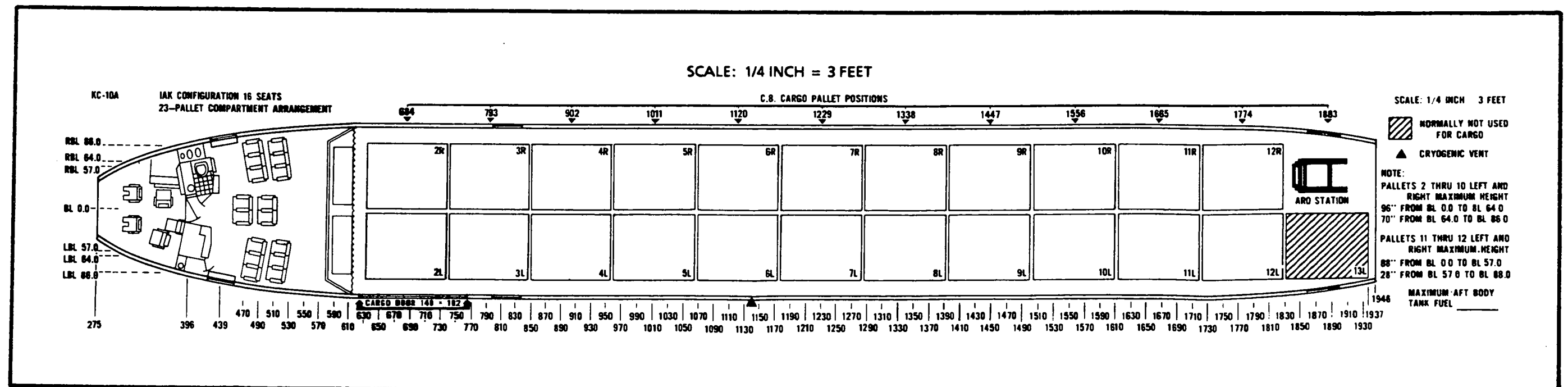
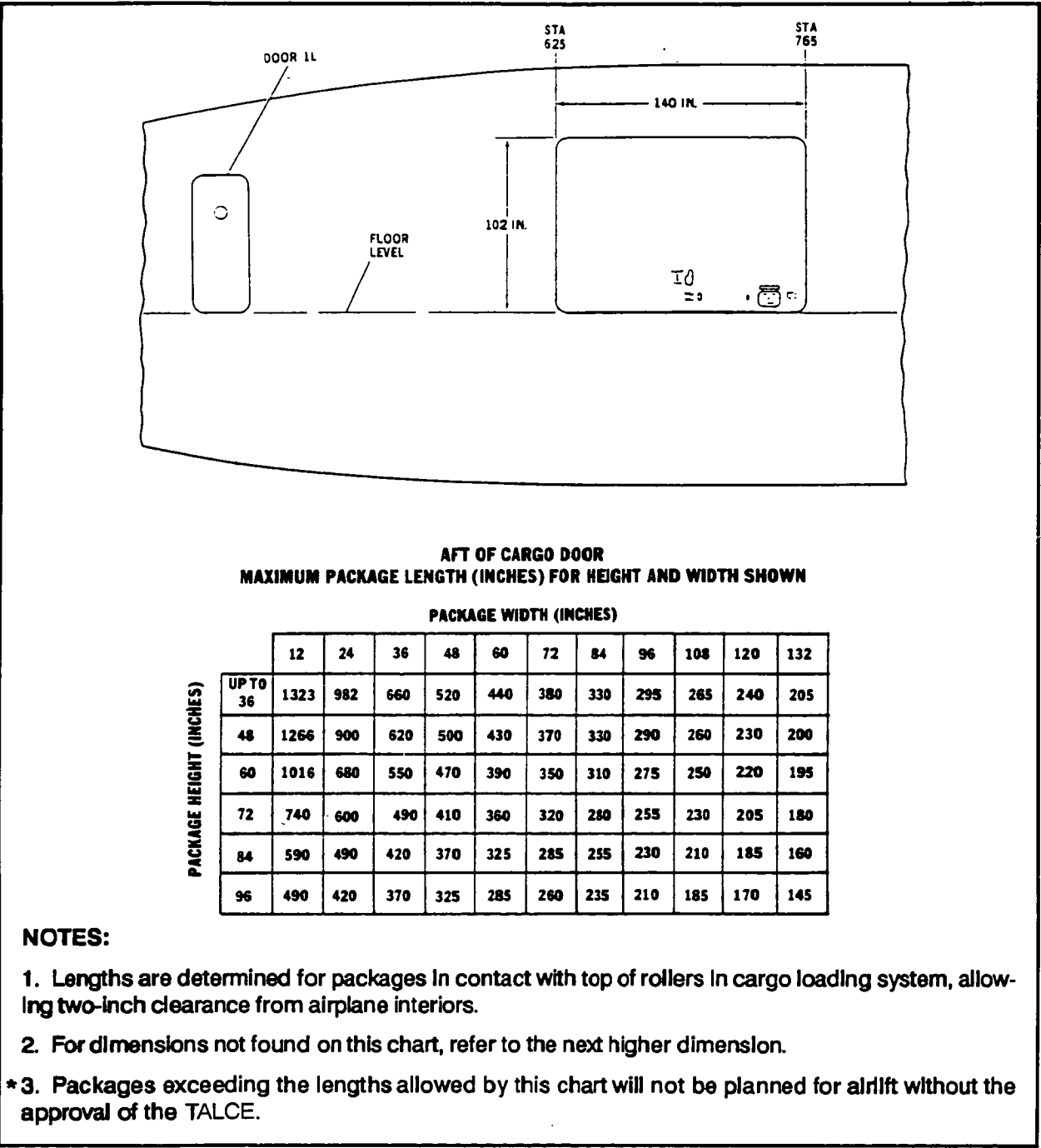


Figure 2-24. KC-10 Schematic—23 Pallets Configuration (Code B).



* Figure 2-25. KC-10 Package Size Chart-Cargo Loaded Aft of Cargo Door.

The pallet profile limitations also apply to wheeled equipment. In addition, allowable axle weights and axle separations (Figure 2-26 and 2-27) must not be exceeded. (Exceptions are allowed according to T.O. 1C-10(K)A-9. Section V

outlines specific loading procedures for items that do not fit within general loading criteria or require a waiver of the aircraft limitations; for example, M-35A2 2 1/2-ton cargo truck [without winch], Figures 2-28, 2-29, and 2-30.)

Figure 2-26. Cargo Loading Data.

PALLET POSITIONS/COMPARTMENT LEFT OR RIGHT		REFERENCE DATA					COMPARTMENT LOAD LIMITATIONS				② MAXIMUM AXLE AND WHEEL WEIGHTS FOR VEHICLES, PNEUMATIC TIRES (LBS)			
PALLET POSITIONS (FLOOR MARKINGS)	PALLET COMPARTMENTS (SIDEWALL MARKINGS)	CENTROID	FLOOR AREA (SQUARE FEET)	VOLUME (CUBIC FEET)	FORWARD LIMIT STATION	AFT LIMIT STATION	MAXIMUM FLOOR LOADING (LBS/LINEAR FOOT)		MAXIMUM TOTAL COMPARTMENT LOAD (LBS) LEFT OR RIGHT		LOADING OFF-LOADING		FLIGHT	
							LOADING	FLIGHT	LOADING	FLIGHT	MAXIMUM TIRE	MAXIMUM AXLE	MAXIMUM TIRE	MAXIMUM AXLE
		1	2	3	4	5	6	7	8	9	10	11	12	13
1.	A	575	66	358	921	630	1,452	738	10,000	6,500	3,000	6,000	③ -	③ -
2	B	684	66	468	810	739	1,452	738	10,000	6,500	3,000	6,000	2,250	4,500
3	C	793	66	468	739	848	1,452	738	10,000	6,500	3,000	6,000	2,250	4,500
4	D	902	66	468	848	957	1,452	738	10,000	6,500	3,000	6,000	2,250	4,500
5	E	1,011	66	468	957	1,066	1,452	738	10,000	6,500	3,000	6,000	2,250	4,500
6	F	1,120	66	468	1,066	1,175	1,452	888	10,000	6,500	3,000	6,000	2,400	4,800
7	G	1,229	66	468	1,175	1,284	1,452	1,452	10,000	10,000	3,000	6,000	1,600	3,200
8	H	1,338	66	468	1,284	1,393	1,452	1,452	10,000	10,000	3,000	6,000	1,600	3,200
9	J	1,447	66	468	1,393	1,502	1,452	1,452	10,000	10,000	3,000	6,000	1,600	3,200
10	K	1,556	66	468	1,502	1,611	1,452	1,388	10,000	10,000	3,000	6,000	2,000	4,000
11	L	1,665	66	395	1,611	1,720	1,452	1,110	10,000	10,000	3,000	6,000	2,000	4,000
12	M	1,774	66	395	1,720	1,829	1,452	738	10,000	6,500	3,000	6,000	2,000	4,000
① 13	N	1,883	66	371	1,829	1,937	1,452	738	10,000	6,500	3,000	6,000	2,000	4,000

NOTES:

- 1 Compartment 13(N) pertains to left side only.
- 2 Wheels must be 48 inches apart. These allowables are for any location on the pallet. Treat dual wheels as one wheel.
- 3 Only compressible cargo should be loaded in the first position occupied aft of the cargo barrier net.

ALLOWABLE AXLE WEIGHT ON KCU-8E PALLETS													
DISTANCE BETWEEN WHEELS (INCHES)	PALLET POSITION/COMPARTMENT ALLOWABLE WEIGHT (POUNDS)												
	D	C	D	C	F	G	H	J	H	L	M	N	
	2	3	4	5	6	7	8	9	10	11	12	13	
	R	R	R	R	R	R	R	R	R	R	R	R	
	L & L	L	L & L	L & L	L	L & L	L	L & L	L & L	L	L & L	L	
8		2.250			2.400		1.600			2.000			
9		2.308			2.460		1.640			2.050			
10		2.362			2.520		1.680			2.100			
11		2.419			2.580		1.720			2.150			
12		2.475			2.640		1.760			2.200			
13		2.531			2.700		1.800			2.250			
14		2.587			2.760		1.840			2.300			
15		2.644			2.820		1.880			2.350			
16		2.700			2.880		1.920			2.400			
17		2.756			2.940		1.960			2.450			
18		2.812			3.000		2.000			2.500			
19		2.869			3.060		2.040			2.550			
20		2.925			3.120		2.080			2.600			
21		2.981			3.180		2.120			2.650			
22		3.037			3.240		2.160			2.700			
23		3.094			3.300		2.200			2.750			
24		3.150			3.360		2.240			2.800			
25		3.206			3.420		2.280			2.850			
26		3.262			3.480		2.320			2.900			
27		3.319			3.540		2.360			2.950			
28		3.375			3.600		2.400			3.000			
29		3.431			3.660		2.440			3.050			
30		3.487			3.720		2.480			3.100			
31		3.544			3.780		2.520			3.150			
32		3.600			3.840		2.560			3.200			
33		3.656			3.900		2.600			3.250			
34		3.712			3.960		2.640			3.300			
35		3.769			4.020		2.680			3.350			
36		3.825			4.080		2.720			3.400			
37		3.881			4.140		2.760			3.450			
38		3.938			4.200		2.800			3.500			
39		3.994			4.260		2.840			3.550			
40		4.050			4.320		2.880			3.600			
41		4.106			4.380		2.920			3.650			
42		4.162			4.440		2.960			3.700			
43		4.219			4.500		3.000			3.750			
44		4.275			4.560		3.040			3.800			
45		4.331			4.620		3.080			3.850			
46		4.387			4.680		3.120			3.900			
47		4.444			4.740		3.160			3.950			
48		4.500			4.800		3.200			4.000			

AXLE LOADS

- USE LESSER OF TREAD OR WHEELBASE.
- CHECK BOTH AXLES TO DETERMINE ACCURATE TREAD DIMENSION.
- TREAT DUAL WHEELS AS ONE WHEEL.

- THE STRUCTURAL LOADING LIMITS AND ZONE LOADING LIMITS MUST ALSO BE OBSERVED.
- FOR SINGLE WHEELS USE ONE-HALF OF VALUES LISTED ABOVE. USE 6-INCH LINE WHEN WHEELS ARE LESS THAN 6 INCHES APART (LATEROALLY OR LONGITUDINALLY).

AXLE LOADS

1. USE LESSER OF TREAD OR WHEELBASE.
2. CHECK BOTH AXLES TO DETERMINE ACCURATE TREAD DIMENSION.
3. TREAT DUAL WHEELS AS ONE WHEEL.

4. THE STRUCTURAL LOADING LIMITS AND ZONE LOADING LIMITS MUST ALSO BE OBSERVED.

5. FOR SINGLE WHEELS USE ONE-HALF OF VALUES LISTED ABOVE. USE 6 INCH LK WHEN WHEELS ARE LESS THAN 6 INCHES APART (LATERALLY OR LONGITUDINALLY).

Figure 2-27. Vehicle Axle Weight Limitations.

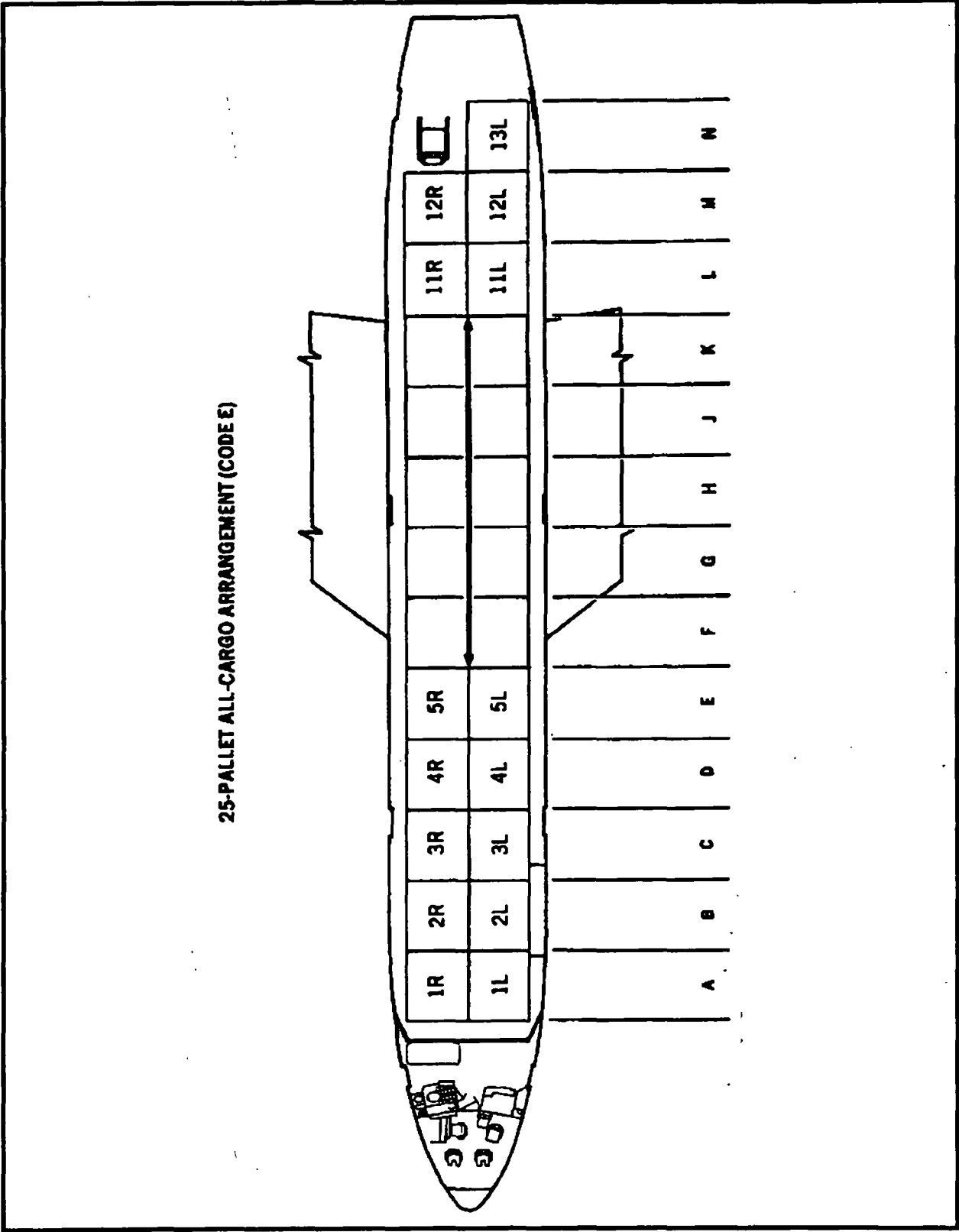


Figure 2-28. Loadable Locations for M-352A Cargo Truck.

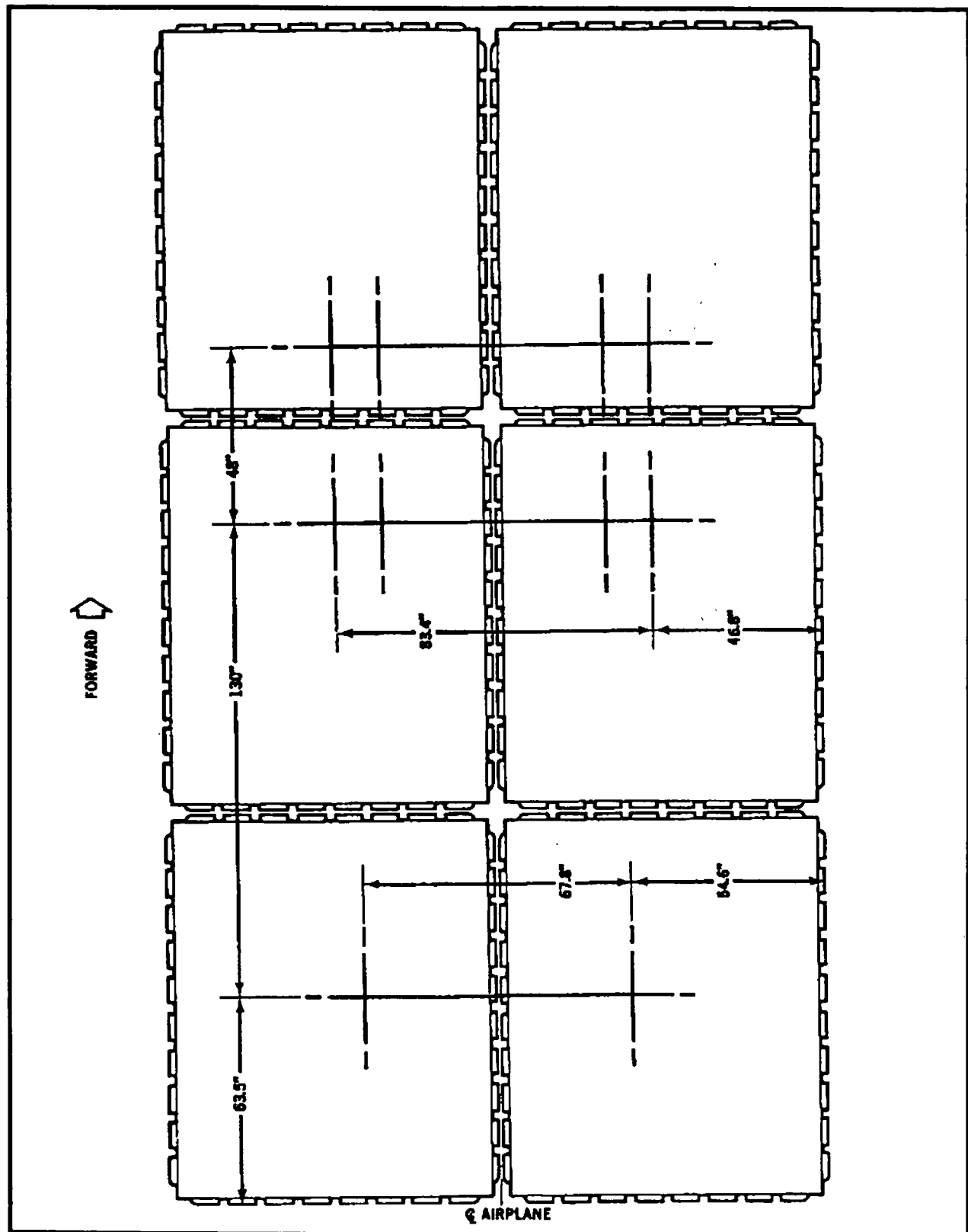


Figure 2-29. Position of M-35A2 Cargo Truck (Centerline-Loaded).

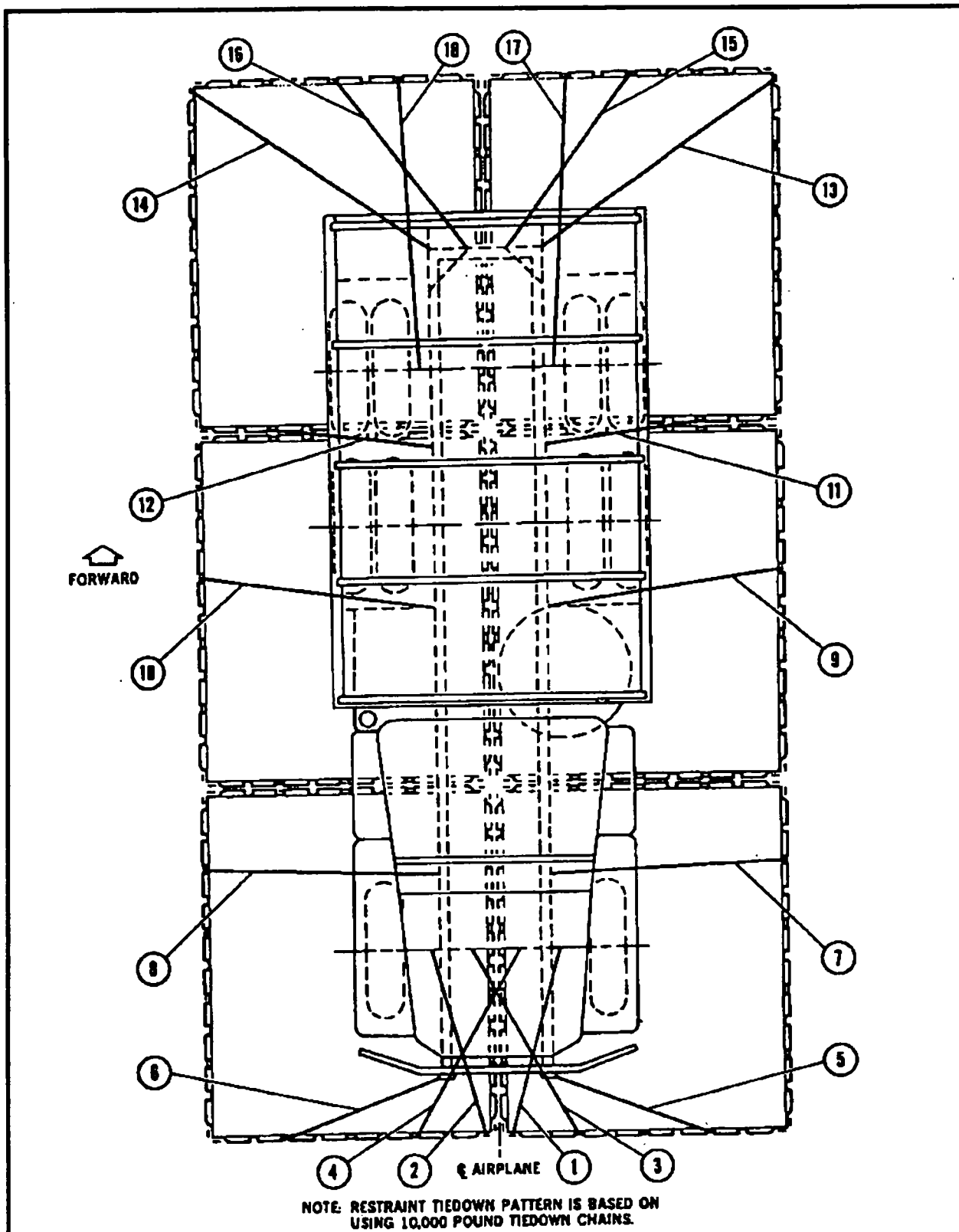


Figure 2-30. Plan View—Tie-Down Pattern for M35A2 Cargo Truck (Centerline-Loaded).

Figures 2-31 and 2-32 show an example of a total CG problem. Figures 2-33 and 2-34 show an example of allowable lateral loading limits.

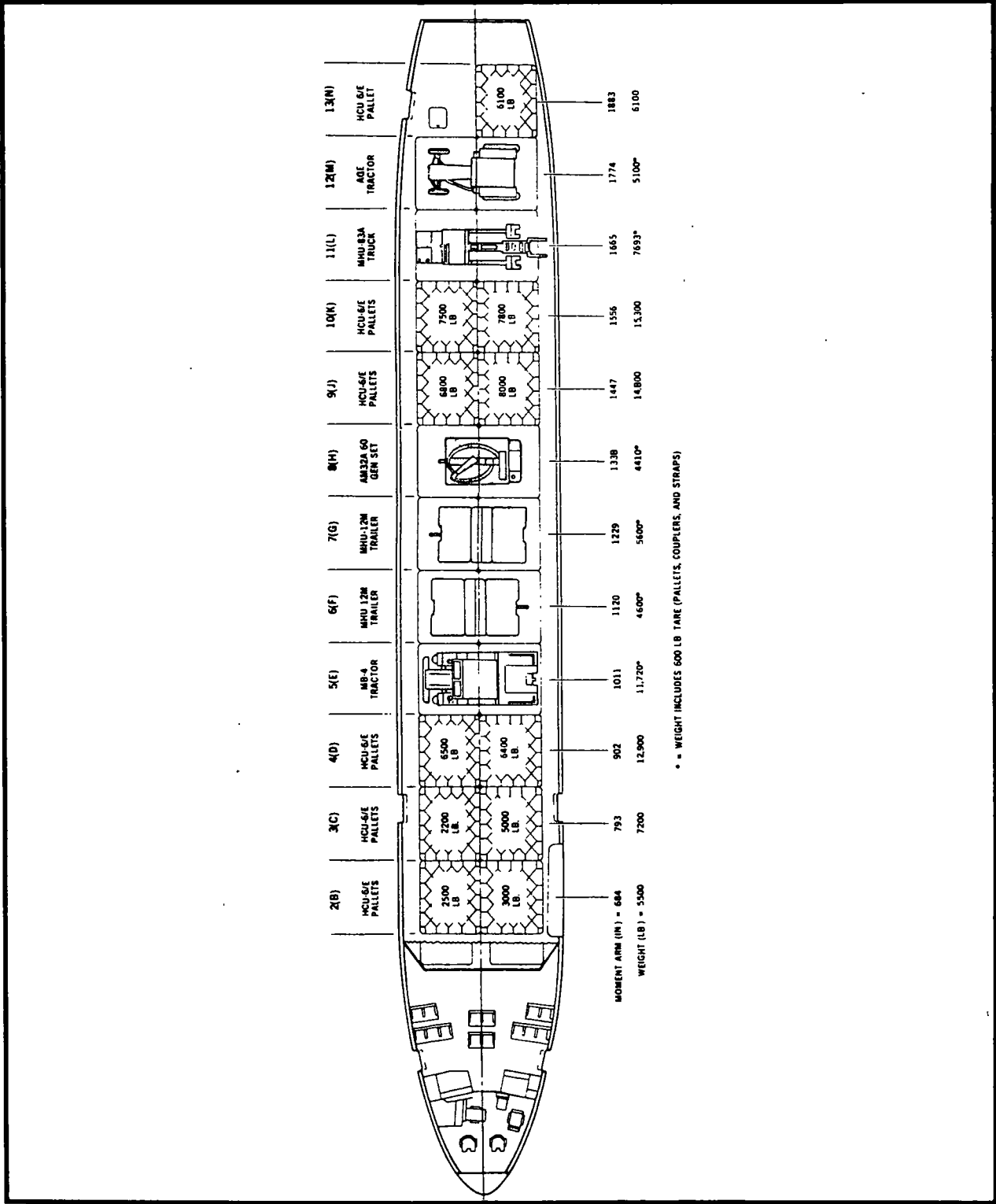


Figure 2-31. Total CG - Sample Problem 1 (Sheet 1).

PALLET POSITION	ITEM	ARM (STATION NO.)	WEIGHT (LB)	MOMENT ($\frac{\text{ARM} \times \text{WEIGHT}}{10,000}$)
13L (N)	HCU-6/E PALLET	1883.0	6,100	1,148.63
12L & 12R (M-M)	AGE TRACTOR	1774.0	5,100	904.74
11L & 11R (L-L)	MHU-83A/E TRUCK	1653.0	7,593	1,280.88
10L & 10R (K-K)	TWO HCU-6/E PALLETS (7,800 & 7,500 LBS)	1556.0	15,300	2,380.68
9L & 9R (J-J)	TWO HCU-6/E PALLETS (8,000 & 6,800 LBS)	1447.0	14,800	2,141.56
8L & 8R (H-H)	AM32A-60 GEN SET	1338.0	4,410	590.06
7L & 7R (G-G)	MHU-12M TRAILER	1228.0	5,600	688.24
6L & 6R (F-F)	MHU-12M TRAILER	1120.0	4,600	515.20
5L & 5R (E-E)	MB-4 TRACTOR	1011.0	11,720	1,184.89
4L & 4R (D-D)	TWO HCU-6/E PALLETS (6,400 & 6,500 LBS)	902.0	12,900	1,163.58
3L & 3R (C-C)	TWO HCU-6/E PALLETS (5,000 & 2,200 LBS)	793.0	7,200	570.96
2L & 2R (B-B)	TWO HCU-6/E PALLETS (3,000 & 2,500 LBS)	684.0	5,500	376.20
TOTALS			100,923	12,945.62

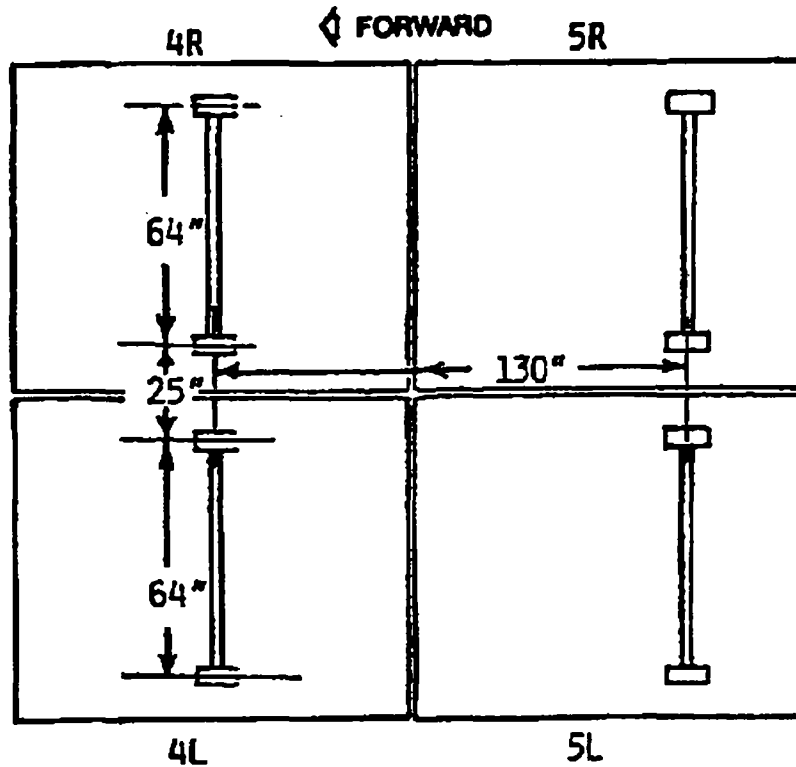
NOTES:

1. THIS TABLE IS USED FOR CALCULATING THE C.G. OF THE CARGO LOAD AND NOT FOR SEQUENCE OF ACTUAL LOADING OPERATIONS.

2. TOTAL LOAD C.G. = $\frac{\text{MOMENT}}{\text{WEIGHT}} = \frac{12,945.62}{100,923} \times 10,000 = 1282.7$

Figure 2-32. Sample Problem 1 (Sheet 2).

TWO VEHICLES ARE TO BE LOADED AS SHOWN BELOW ON PALLET POSITIONS 4L, 4R, 5L, AND 5R. CALCULATE THE LOAD LIMITS.



1. APPLIED LOAD - PALLET POSITION 4R AXLE WEIGHT = 4,400 POUNDS
 PALLET POSITION 5R AXLE WEIGHT = 2,850 POUNDS
 PALLET POSITION 4L AXLE WEIGHT = 4,400 POUNDS
 PALLET POSITION 5L AXLE WEIGHT = 2,850 POUNDS
2. DISTANCE BETWEEN LOADS - ALL AXLE TREADS = 64 INCHES
 BOTH WHEEL BASES = 130 INCHES
 LATERAL AXLE SEPARATION = 25 INCHES
3. ALLOWABLE LOAD - PALLET POSITION 4R = _____ (AXLE)
 PALLET POSITION 4L = _____ (AXLE)
 PALLET POSITION 5R = _____ (AXLE)
 PALLET POSITION 5L = _____ (AXLE)
 ADJACENT PALLET = _____ (AXLE)

Figure 2-33. Sample Problem 2 (Sheet 1).

4. COMPARE THE ALLOWABLE LOADS TO THE APPLIED LOADS - WHEELS

ALLOWABLE LOAD	APPLIED LOADS	APPLIED LOADS	LOADABLE?
4R/5R $+ 2 =$	4R $+ 2 =$	5R $+ 2 =$	
4L/5L $+ 2 =$	4L $+ 2 =$	5L $+ 2 =$	
ADJ-4 $+ 2 =$	ADJ-4 WHEEL		
ADJ-5 $+ 2 =$	ADJ-5 WHEEL		

THE ALLOWABLE LOADS ARE LESS THAN THE APPLIED LOADS. THEREFORE, ADDITIONAL SPACING IS REQUIRED IN ORDER TO LOAD THESE VEHICLES ON ADJACENT PALLETS. SINCE ADDITIONAL SPACING CANNOT BE OBTAINED BY MOVING THE VEHICLES APART Laterally, THE VEHICLES SHOULD BE OFFSET LONGITUDINALLY AS ILLUSTRATED BELOW.

FIGURE 2-31 INDICATES THAT A MINIMUM SPACING OF 47 INCHES BETWEEN THE WHEELS IS REQUIRED TO SUPPORT A WHEEL LOAD OF 2,200 POUNDS. IF THE VEHICLE ON THE RIGHT SIDE IS MOVED AFT SO THAT THE DIAGONAL MEASUREMENT BETWEEN THE WHEELS IS AT LEAST 47 INCHES, THE ALLOWABLE LOADS CAN BE RECOMPUTED. WITH THE LOAD SHIFT, THE APPLIED LOADS ARE NOW LESS THAN THE ALLOWABLE LOADS; THEREFORE, THE VEHICLES CAN BE LOADED IN THE NEW CONFIGURATION.

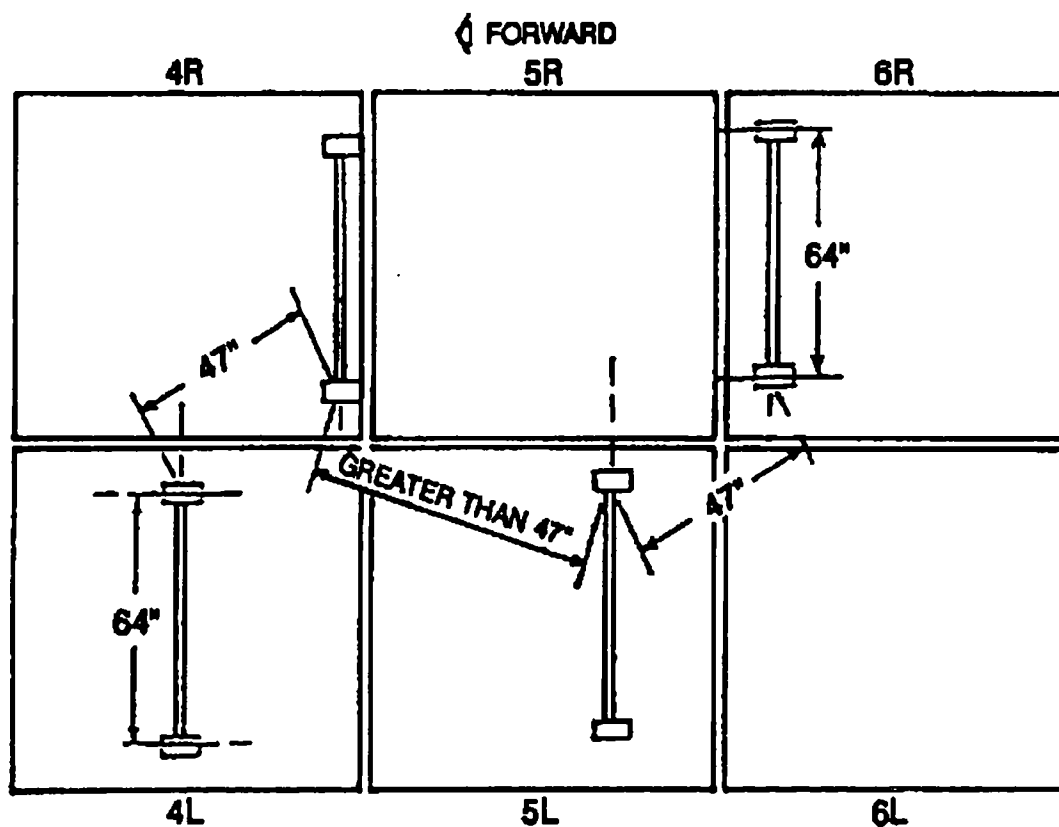


Figure 2-34. Sample Problem 2 (Sheet 2).

C-17 Characteristics

The C-17 is a high-winged, long-range, heavy-lift four-engine turboprop transport aircraft (Figure 2-35). It is designed to replace the aging C-141 fleet as the airlift workhorse. The C-17 can deliver outsized equipment into small austere airfields (SAAFs), previously restricted to the C-130. As of publication, the C-17 has not completed its test and evaluation program and the design freeze has not yet been accomplished.

Passenger Considerations. The C-17 does not have a separate passenger compartment. However, it has 54 side-facing seats permanently installed for passenger use in the cargo compartment. These sidewall seats do not affect the cargo

area dimensions. For planning purposes, estimate each passenger to weigh 210 pounds. This weight may vary with type of mission (refer to FM 55-12) and should be confirmed with AMC as early as possible. The C-17 will carry a maximum of 102 passengers with centerline seats installed on the cargo floor (Figure 2-36). Also, up to 48 litters (Figure 2-37) may be installed (150 passengers, patients, and medical crew over water based on life raft capacity).

Palletized Cargo Restrictions. The C-17 can accommodate up to 18 463L pallets—14 on the aircraft floor and 4 on the aircraft ramp (Figure 2-38). Figure 2-38 lists pallet position weight limitations.

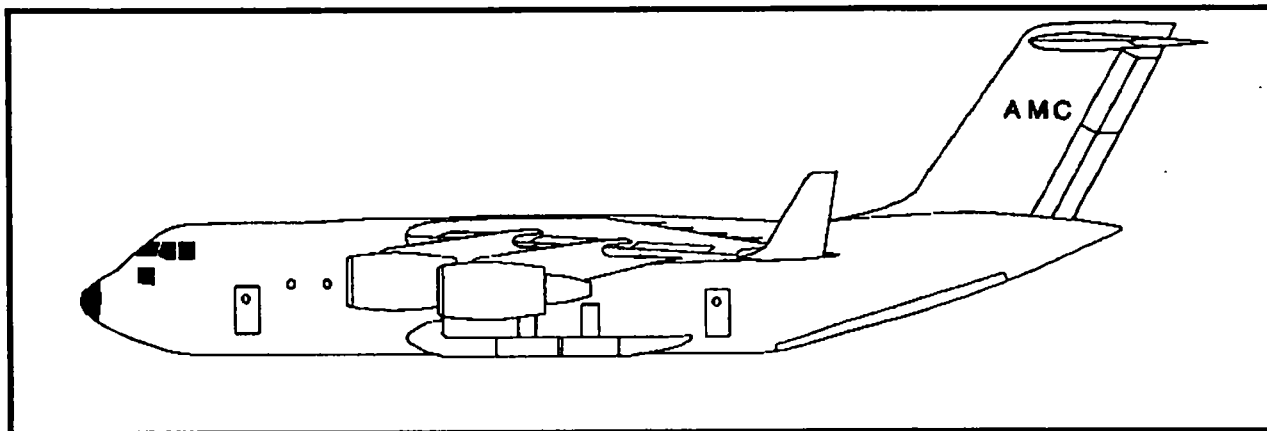


Figure 2-35. C-17 Aircraft.

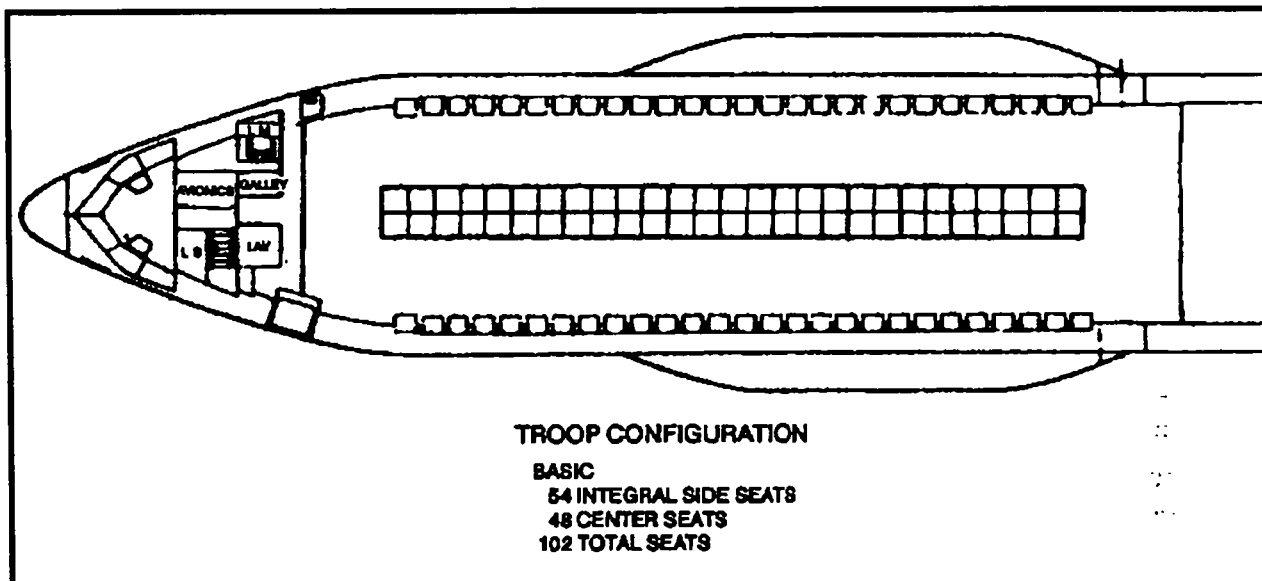


Figure 2-36. C-17 Cargo Compartment Seating.

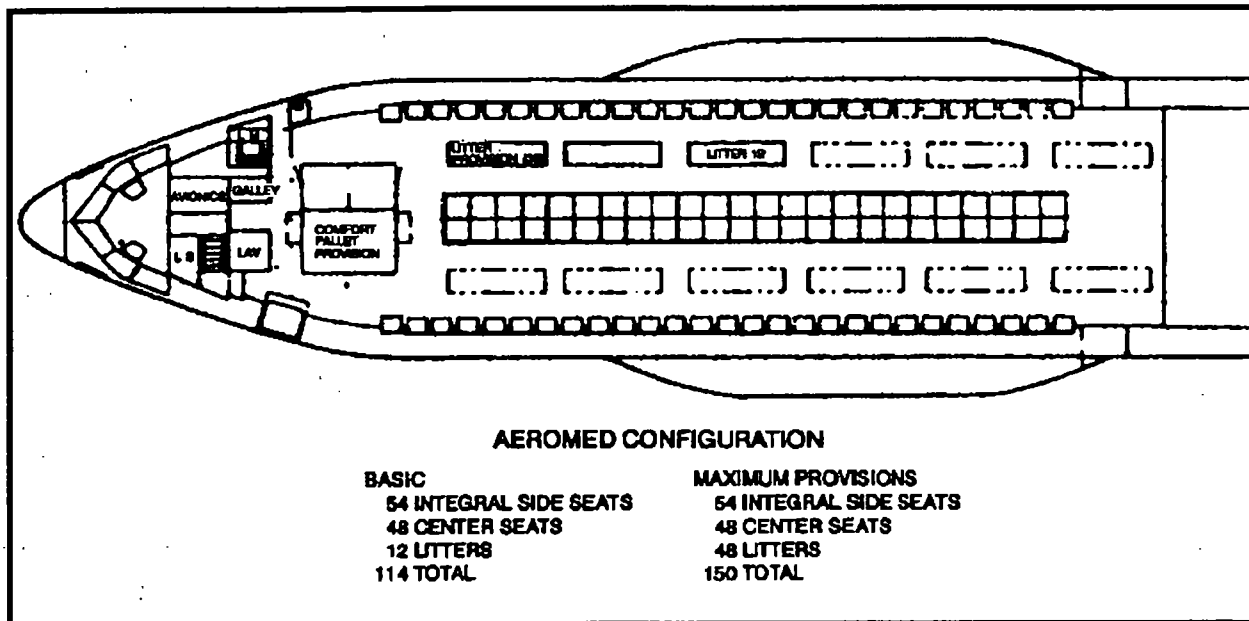


Figure 2-37. Aeromed Configuration.

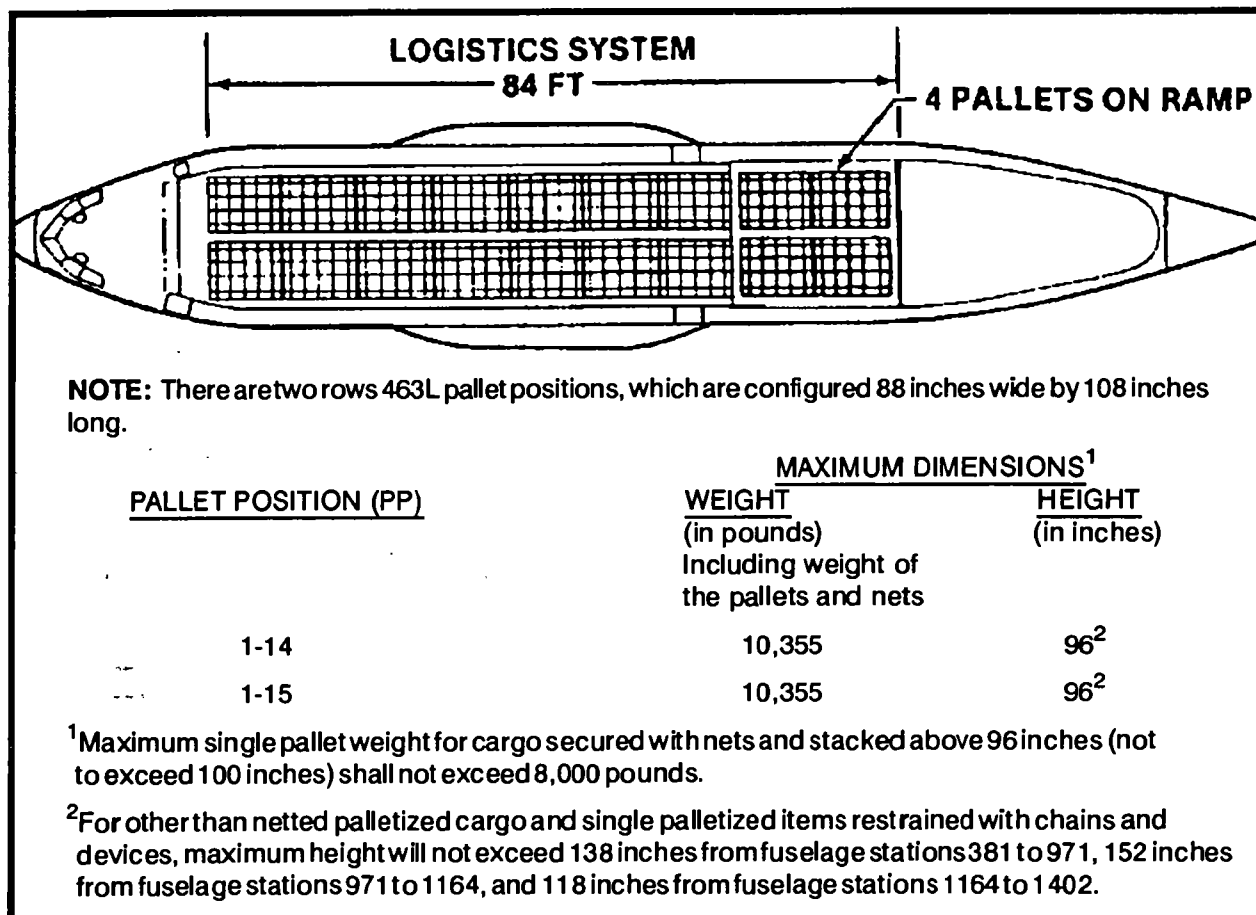


Figure 2-38. C-17 Pallet Positions.

Loading Guidance. The cargo area dimensions in Table 2-6 are for general planning purposes only (Figures 2-39 and 2-40).

The schematic in Figure 2-41 shows the fuselage station numbers and cargo tie-down locations.

NOTE: Certified center of balance information is not currently available.

Rolling Stock Restrictions. The cargo floor is a load-carrying structure across its whole width. Vehicles can traverse its whole area and maneuver freely during loading operations. In flight, single

40,000-pound axle loads or a combination of axles weighing up to 40,000 pounds may be carried on any continuous 42-inch longitudinal length of cargo floor area between fuselage stations 577 and 1072. Figure 2-42 also shows the in-flight load limitations on other floor areas and on the ramps. The capability of the ramps and floor is such that tanks and other tracked vehicles weighing up to 129,000 pounds can be loaded and transported. Vehicles whose height exceeds 142 inches will not be planned forward of FS 971 (Figure 2-41). Vehicles whose height exceeds 142 inches but less than 156 inches will be planned aft of FS 971 or must be reduced to 142 inches.

Table 2-6. C-17 Cargo Area Dimensions.

<u>USABLE CARGO AREA</u>	<u>RAMP LIMITATIONS</u>
Length - 1,022 inches	Pallet: Height - 96 inches
Width - 216 inches	Weight - 10,355 pounds ¹
Height - 142 inches ²	Vehicle: Height - 122 inches
Height - 158 inches ³	Weight - 27,000 pounds per axle

¹Not to exceed a combined total ramp weight of 40,000 pounds.
²Fuselage stations 381 to 971.
³Fuselage stations 971 to 1164.

NOTE: Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual.

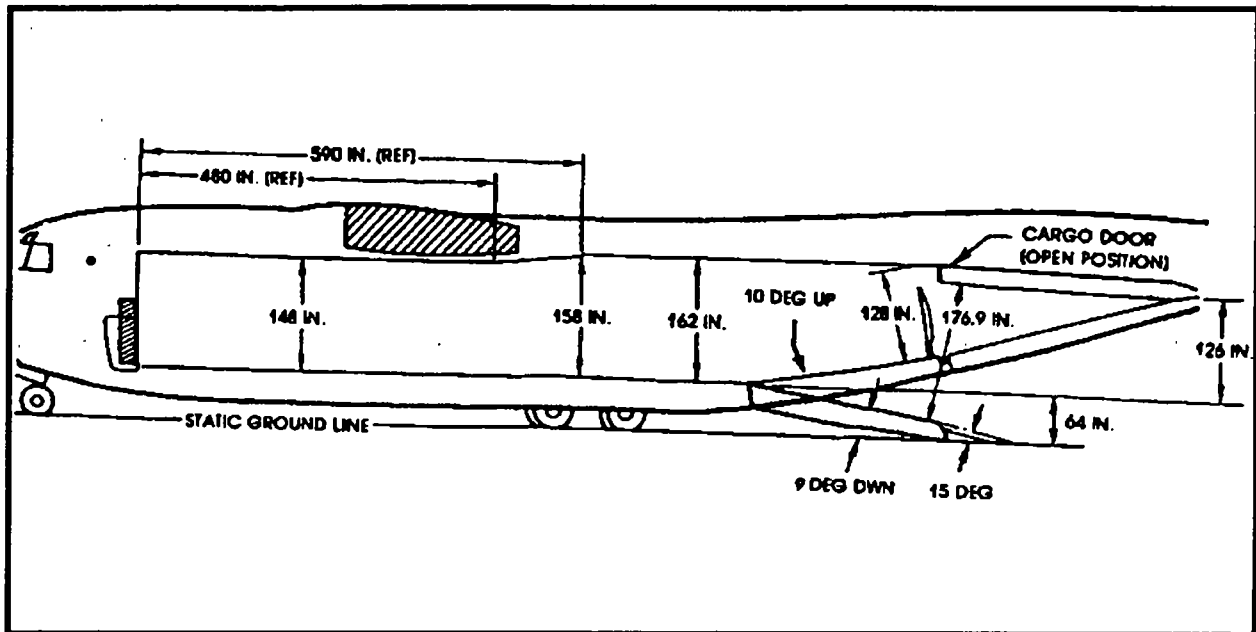


Figure 2-39. C-17 Cargo Compartment Height Dimensions.

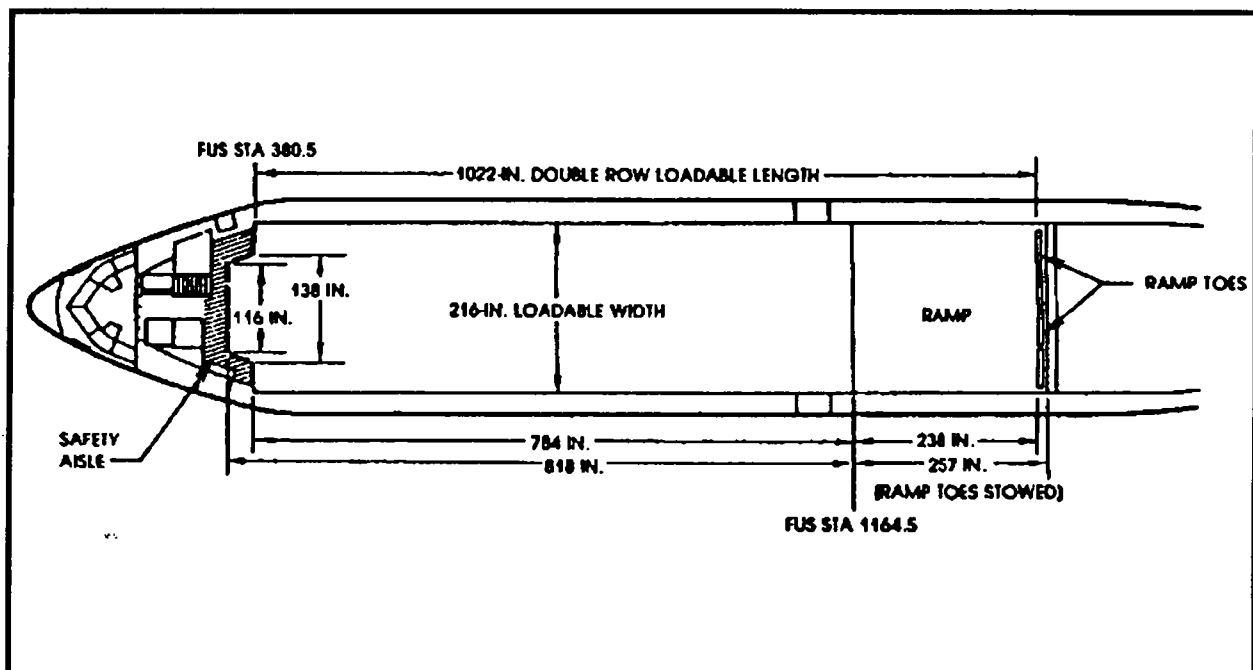


Figure 2-40. C-17 Cargo Compartment Floor Dimensions.

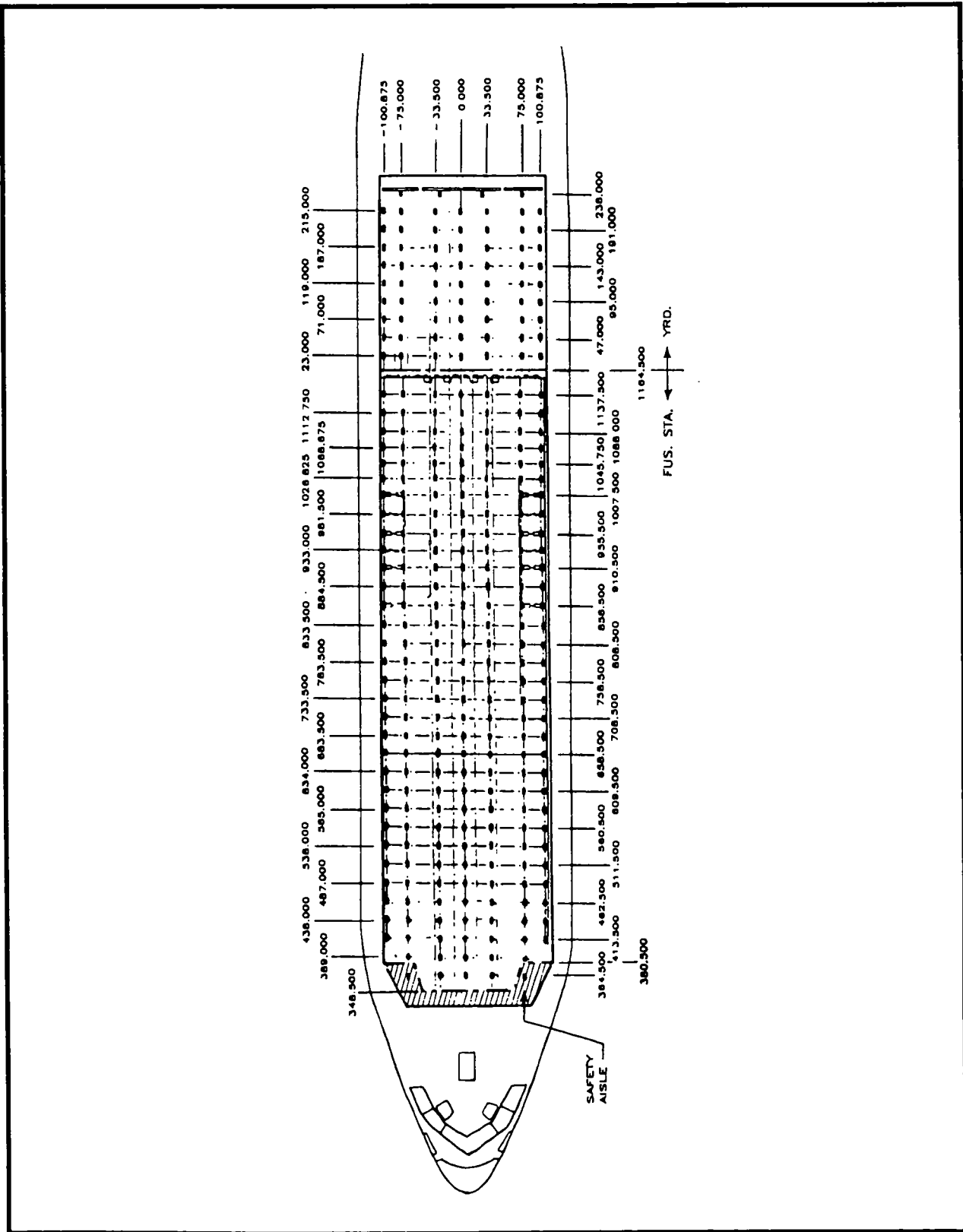
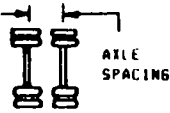
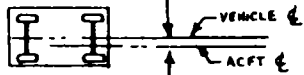
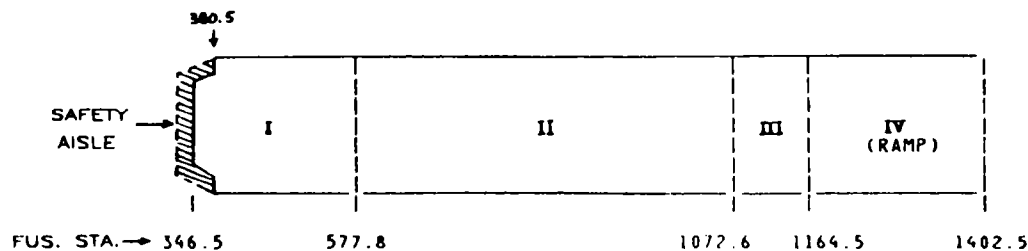


Figure 2-41. C-17 Schematic.

Figure 2-42. Flight Limitations Chart.

				VEHICLE CENTERLINES MORE THAN 8 INCHES FROM AIRCRAFT CENTERLINE (DOUBLE ROW)		VEHICLE CENTERLINE WITHIN 8" OF AIRCRAFT CENTERLINE (SINGLE ROW)		
								
C-17 CARGO COMPARTMENTS	MAXIMUM ALLOWABLE WEIGHT IN COMPARTMENT (LB.)	MAXIMUM ALLOWABLE PNEUMATIC TIRE INFLATABLE PRESSURE (PSI)	MAXIMUM ALLOWABLE WEIGHT PER LINEAR FOOT (LB.)	SINGLE AXLES SIDE BY SIDE (LB.)	BOGIES (TANDEM) SIDE BY SIDE (LB.)	SINGLE AXLE BESIDE 4,500 LB. AXLE (LB.)	SINGLE AXLE VEHICLE (WITHIN 8" OF CENTERLINE) (LB.)	TRACKED VEHICLES (LB.)
I	70,000	100	6,200	13,000	23,000 54" AXLE SPACING	22,000	27,000	UNDER 65,000
II	172,200	100	8,670	20,000	40,000 42" AXLE SPACING	27,000	36,000	OVER 65,000 (Veh. within 8" of centerline)
III	38,000	100	6,200	13,000	23,000 54" AXLE SPACING	22,000	27,000	UNDER 65,000
IV (RAMP)	40,000	100	6,200	13,000	23,000 54" AXLE SPACING	22,000	27,000	UNDER 65,000





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CHAPTER 3

CIVIL RESERVE AIR FLEET AIRCRAFT**INTRODUCTION**

This chapter defines the Civil Reserve Air Fleet (CRAF) program and describes selected civilian aircraft for planning purposes. CRAF is a program that uses commercial aircraft support capabilities of select US civil air carriers to rapidly augment organic military airlift forces during crises. CRAF combines commercial cargo and passenger long-range and short-range airlift capability to meet emergency airlift requirements. The number of CRAF aircraft changes monthly based on contract negotiations.

CRAF can be activated in three stages:

- Stage I may be activated by the USTRANSCOM commander in chief to provide responsive support during a committed expansion of airlift capability. Peacetime procedures remain in effect. This stage is only an expansion of airlift capability contractually committed to call-up. Carriers have 24 hours to make aircraft available for missions.
- Stage II provides additional airlift to support an airlift emergency. This stage increases the capability more than Stage I without resorting to full mobilization. The Secretary of Defense has activation authority for this stage. As with Stage I, carriers have 24 hours to make aircraft available.
- Stage III provides the total CRAF capability for major military emergencies warranting a full mobilization of US forces. The Secretary of Defense issues the order to activate CRAF Stage III only after the President or Congress declares a national emergency. Carriers have 48 hours to make aircraft available.

LOAD PLANNING FOR CRAF AIRCRAFT

Unlike standardized military cargo aircraft, civilian airframes vary widely. It is not uncommon

for the same type, model, and series of civil aircraft to vary greatly depending on the carrier's needs. All CRAF aircraft need some modification before military vehicles and equipment can be loaded and transported on them. See Table 3-1 for examples of CRAF aircraft capabilities. For more in-depth guidance on type, model, and series capabilities, consult Air Mobility Command Pamphlet (AMCP) 55-41, Civil Reserve Air Fleet (CRAF) Load Planning Guide. Units may obtain a copy of AMCP 55-41 from —

FORSCOM:

Commander, US Army Forces Command
ATTN: Publications Stock Room
Building 208
Fort Gillem, Forest Park, GA 30050-5000

EUCOM:

Commander, EUCOM
ATTN: 1st TMCA
APO New York 09451-0127

TRADOC:

Commander, US Army Training and Doctrine Command
ATTN: ATPL-TT
Fort Monroe, VA 23651-5000

WESTCOM:

Commander, US Army, Pacific
ATTN: APLG-TR
Fort Shafter, HI 96858-5100

Other Units:

HQ AMC/SCIPPD
Scott Air Force Base, IL 62225-5441

During total mobilization, as much as 95 percent of all troops deployed are likely to use a civilian aircraft for strategic deployment. In a national emergency, military airlift may be in very short supply, and Air Force aircraft will carry large vehicles and equipment. Planning must include flexibility for maximum use of civilian aircraft. During Operations Desert Shield and Desert Storm, CRAF was activated

for the first time and successfully supported the United States deployment and sustainment to Southwest Asia.

Table 3-1. Examples of Available CRAF Assets.

AIRCRAFT	ACL (ST)	PALLET	TROOPS Max/Min
B-747	90.0	42	492/400
B-757	36.4	NA	218/184
DC-10	75.0	30	354/326
L-1011	NA	NA	334/326
DC-8-63	45.0	18	235/183
DC-8-62	39.2	14	183/NA
B-707	36.5	13	NA/NA

Problems associated with loading CRAF aircraft are not usually encountered in loading military aircraft. The cargo compartment of a B-747, for example, is 16 feet above ground level (AGL). Standard military materials-handling equipment cannot be used to load the aircraft. Like the floors of the KC-10, the floors of all civilian aircraft are not strong enough to withstand the ground pressure of vehicles. A subfloor of 463L pallets must be installed before loading any vehicles. Despite subflooring, any vehicle heavier than a 2 1/2-ton truck cannot be loaded onto most civilian aircraft. Pallet stations may also have weight restrictions, and planners must adjust loads (see AMCP 55-41).

The roller/restraint systems in most civilian aircraft will accept a military 463L pallet, but on most of those aircraft, the rails must be moved before the pallets can be loaded. Height restrictions are also critical. Differences in fuselage configurations will cause pallet load heights to vary, especially in the lower lobes of wide-body aircraft. Review the fuselage cross sections in Figure 3-1 or refer to AMCP 55-41 before planning pallet loads on civilian cargo aircraft.

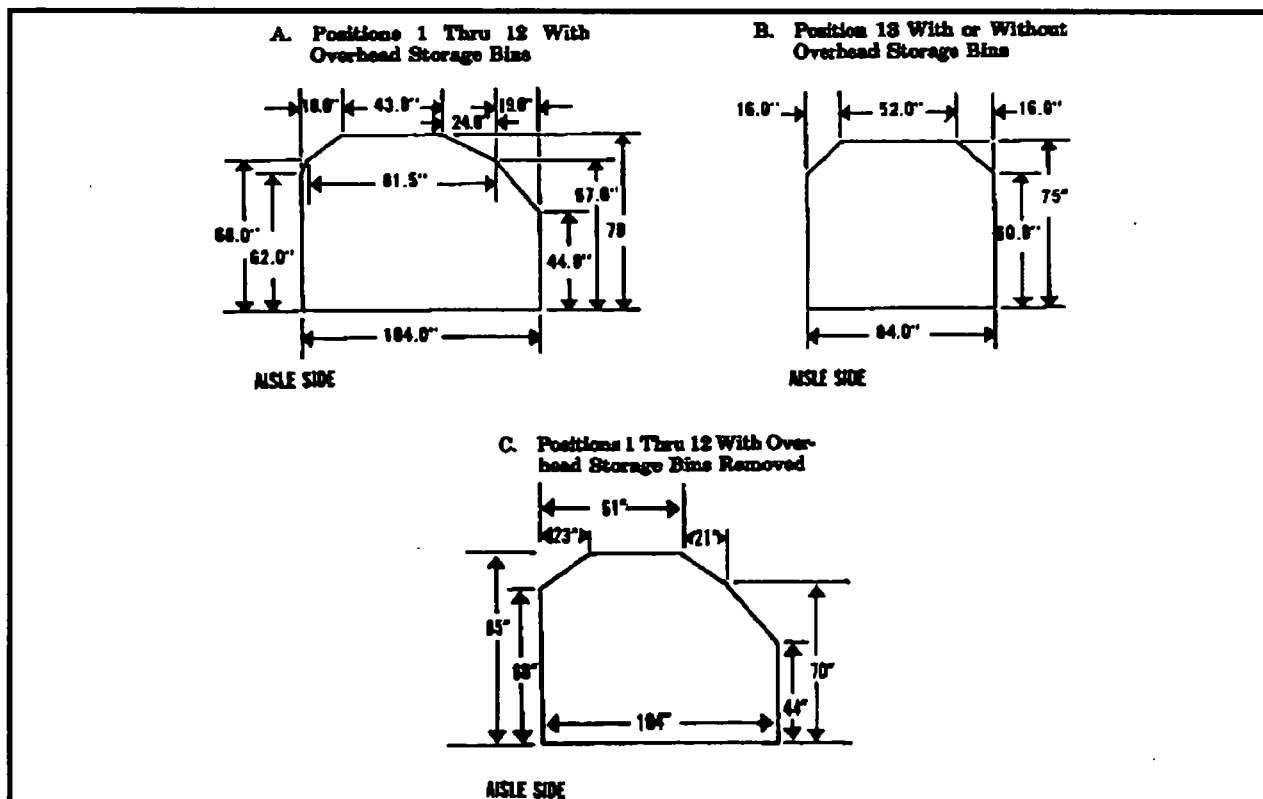


Figure 3-1. CRAF Pallet Profiles (Measurement Taken from Pallet Surfaces).

The width of selected cargo doors may also be restrictive. Except for some B-747 models with ramps, vehicles cannot be driven onto the aircraft as doors on the fuselage sides are relatively small.

Lower lobe/compartments baggage containers normally are not desirable for contingency deployment because of specialized MHE required for loading and unloading. Experience has shown that it is often more efficient to handload baggage into the aircraft whose cargo doors are too narrow for baggage pallets. Planners should note that moving units will require additional assistance for manual uploading. The use of commercial baggage containers normally requires that the loading of bags be delayed until the aircraft arrives at the loading location and that specialized MHE be brought to load the containers. However, in the event that commercial baggage containers are used, the carrier will be responsible for providing the appropriate containers. There are instructions in each of the aircraft sections of AMCP 55-41. Figure 3-2 shows the commercial containers available for use on civil air carriers.

Restraining the cargo once it is aboard the aircraft is another problem. When a pallet subfloor is installed before loading military vehicles, tie-down devices must be applied according to the limits of the pallet. The restraint criteria for civilian aircraft differ from that for Air Force aircraft (see Chapter 7). CRAF criteria are —

- Forward: 1.5 times the force of gravity (g).
- Aft: 1.5 g's.
- Vertical: 2.0 g's.
- Lateral: 1.5 g's.

Since the rings on a 463L pallet are too small to accept an MB-2 (25,000-pound) tie-down device, vehicles can be restrained only with MB-1 (10,000-pound) devices and CGU-1/B (5,000-pound) cargo straps.

Despite these loading problems, CRAF aircraft are a productive and necessary part of airlift planning. The aircraft characteristics and planning data in this manual for each civil aircraft should make planning easier. The use of civil aircraft must be closely coordinated through the affiliated AMC TALCE.

B-707

The B-707 is a four-engine, long-range, narrow-body aircraft (Figure 3-3). It can carry approximately 90,000 pounds of cargo or 142 passengers.

The main deck of the B-707 can carry 13 463L pallets. When 108-inch pallets are loaded, a flip-up rail 17 inches from the left side cargo rail is positioned to receive the pallet. The aft-most pallet must have the 88-inch side facing the front/aft section of the cargo compartment. All military cargo on the main deck will be palletized or loaded on a palletized subfloor. The side door to the main deck is about 10 feet AGL; therefore, items can be loaded with selected standard military MHE (not by the 25K TAC loader).

The lower deck has a forward compartment (Figure 3-4). One door leads to the forward compartment, and two doors lead to the aft compartment. The lower compartments in this narrow-body aircraft have a rounded belly and cannot be loaded with pallets. The compartments normally are loaded with small, hand-transportable cargo items or baggage. These items may be loaded directly onto the floor of the B-707 or into commercial baggage containers.

NOTE: The B-707 may possibly settle on its tail section if improperly loaded. Since the aft section of the main deck normally is loaded first, about 5,000 pounds of cargo must be placed in pallet position 1 before loading the rest of the main deck.

As with most commercial aircraft, loading the lower lobe forward compartment is preferred before loading the aft compartment. If there is a notable weight difference, the heavier cargo should be placed in the forward compartment.

B-747

The B-747 is a wide-body aircraft flown in passenger or cargo configurations (Figure 3-5). The B-747 is normally contracted to carry 364 to 461 passengers (Figure 3-6) or 42 pallet positions (Figure 3-7) at 180,000-pounds ACL. The actual passenger or cargo maximum capability may be higher, based on the series and the individual aircraft configuration.

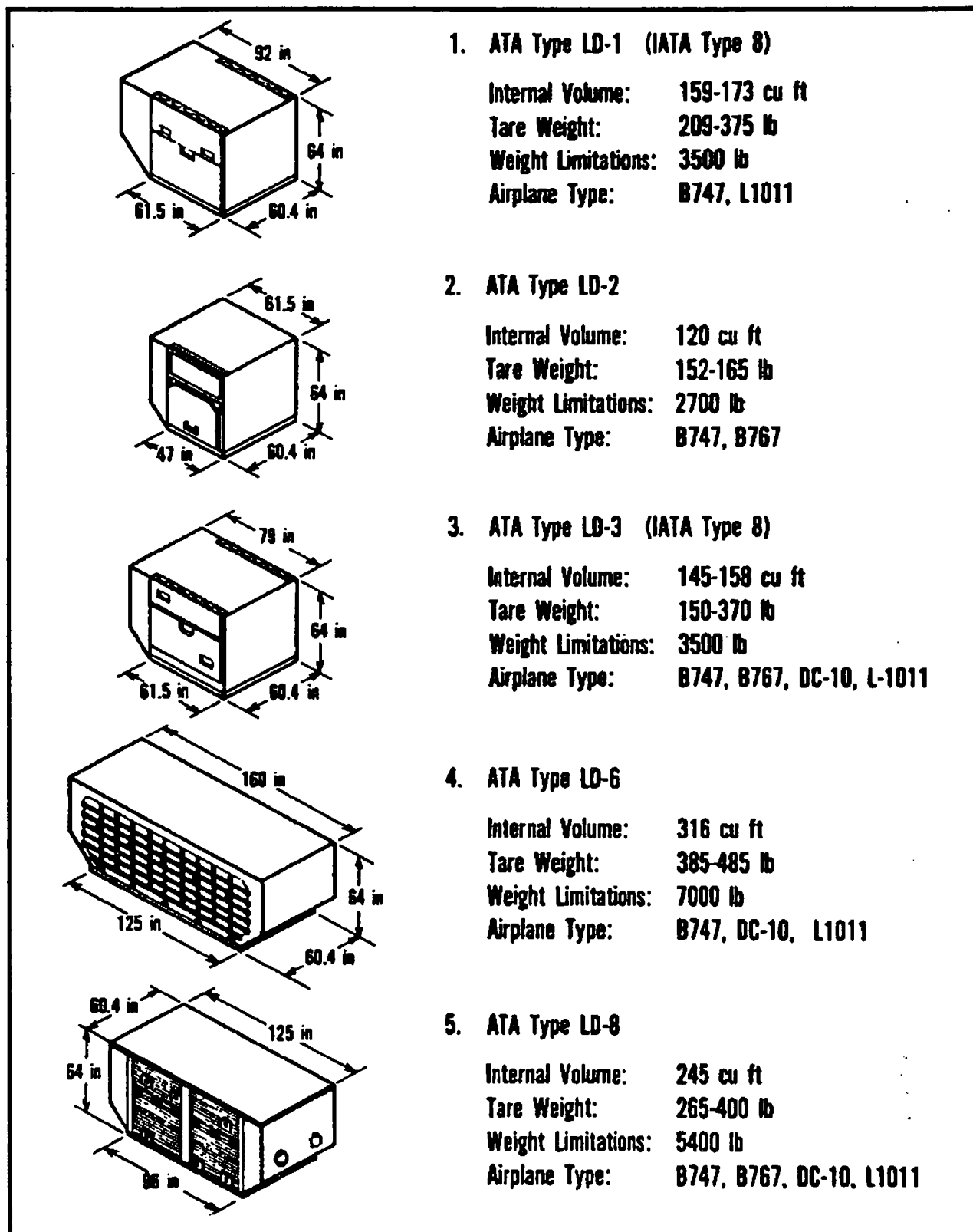


Figure 3-2. Lower Lobe Cargo Containers.

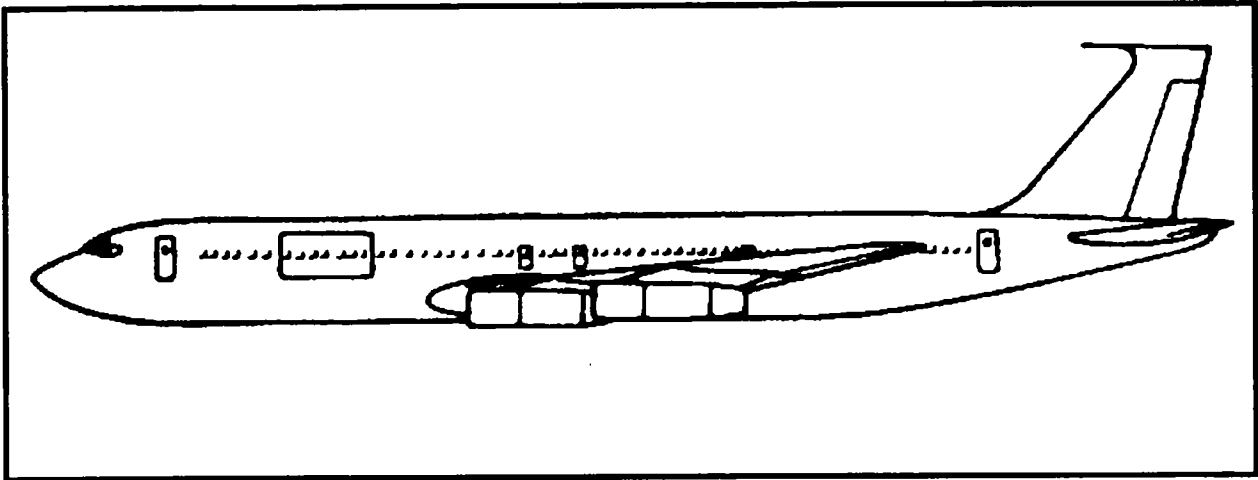


Figure 3-3. B-707.

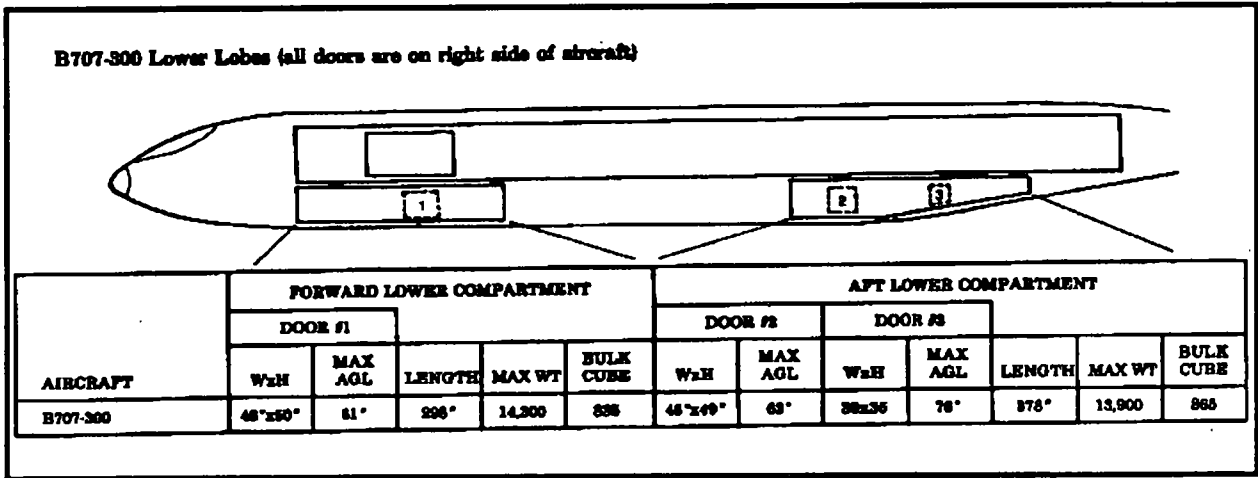


Figure 3-4. B-707-300 Lower Lobes.

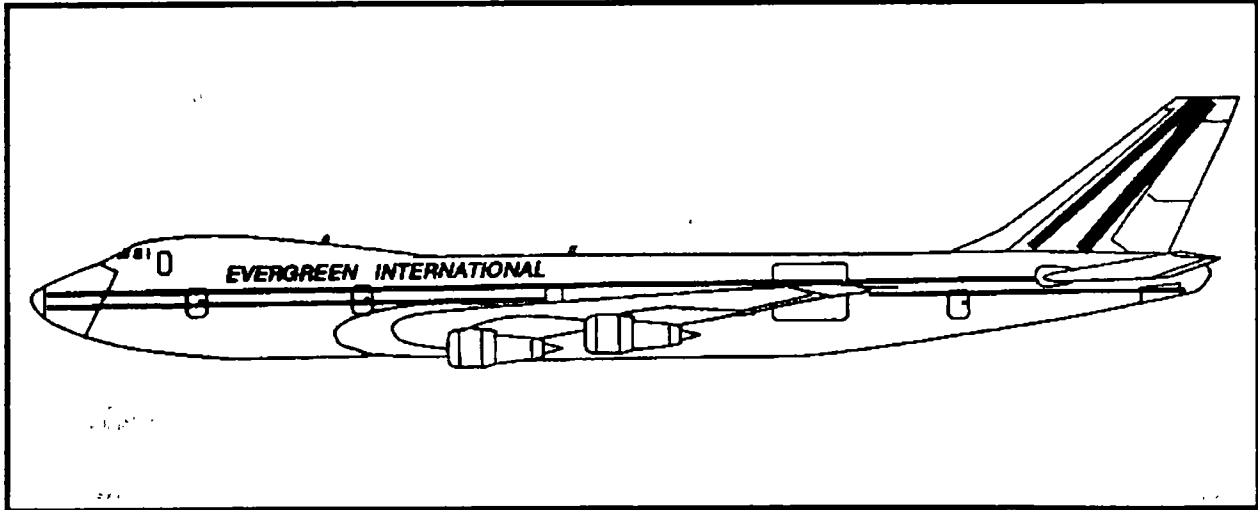


Figure 3-5. B-747.

Figure 3-6. B-747 Typical Seating Arrangements.

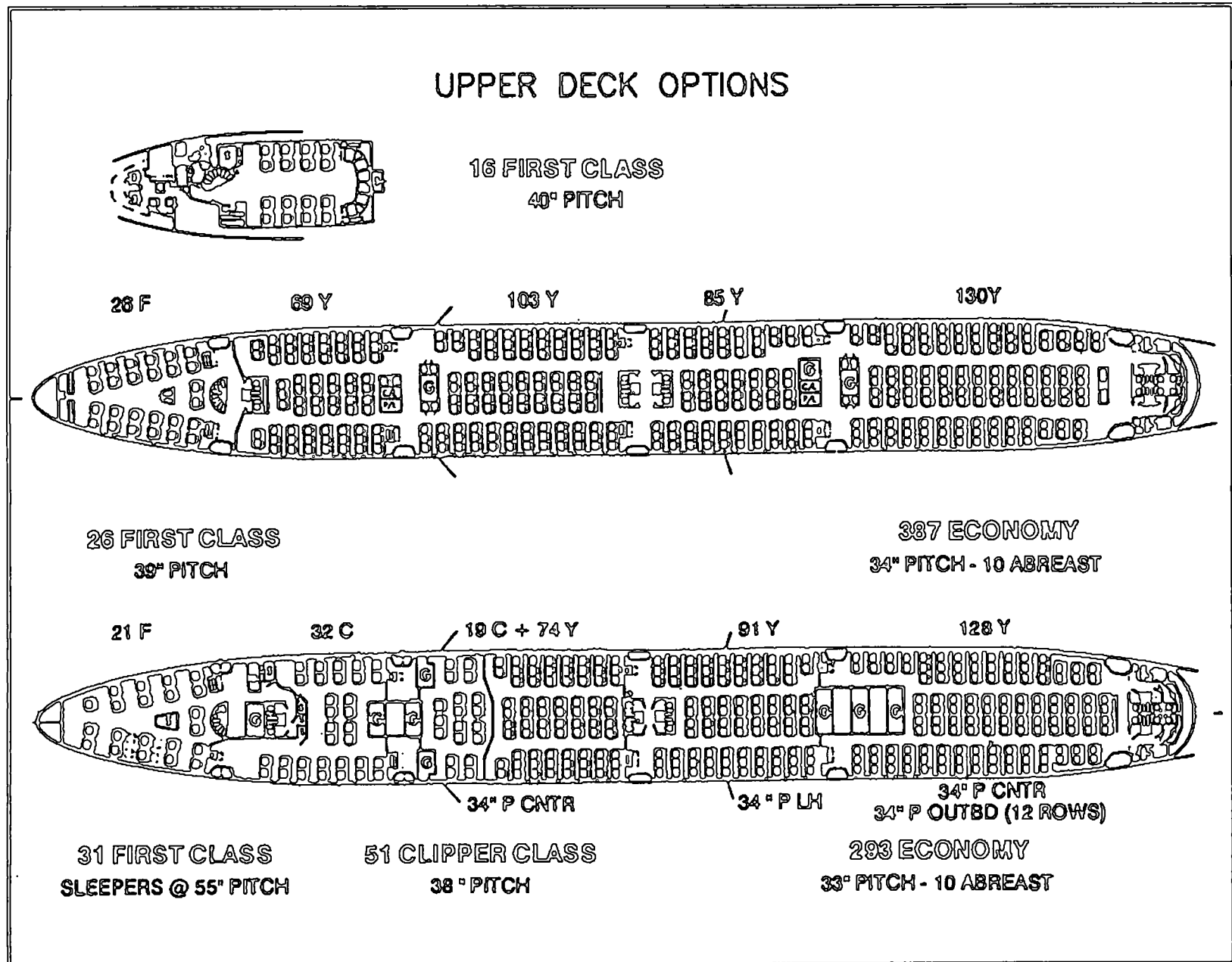


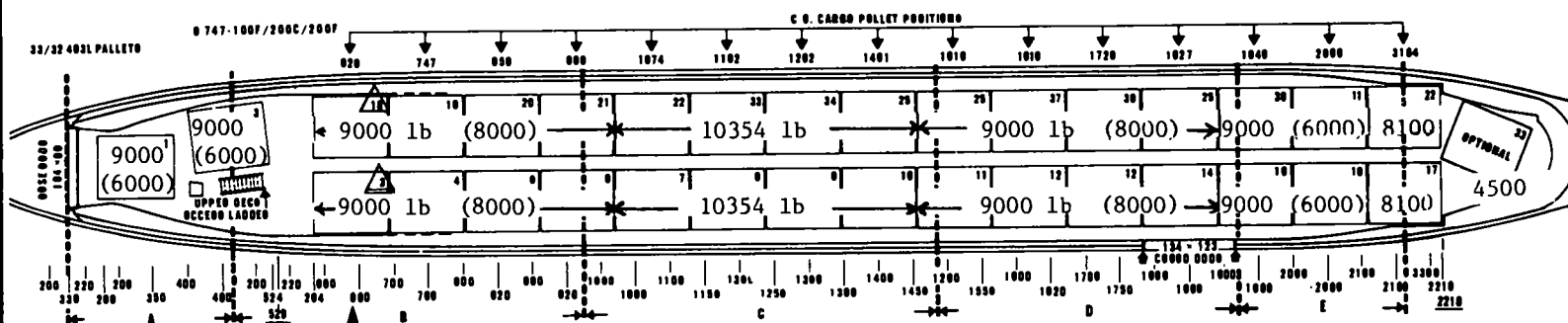
Figure 3-7. B-747 Maximum Weight Table, 33 Pallet.

NOTE: All weight limitations are for general planning purposes; carrier is final authority.

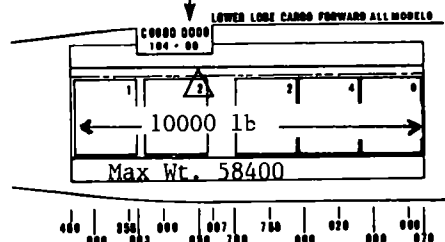
1. All weights are maximums and include weight of pallet and nets.
2. All weights are for 200 series except for those in parentheses () are for 100 series.
3. All weights are for individual pallets.

Directions:

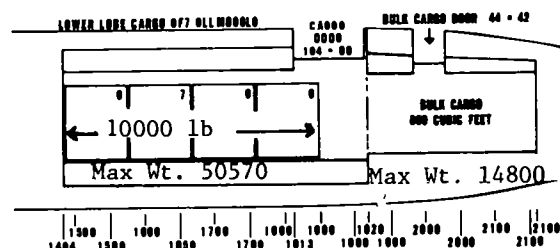
1. Weights on main deck assume empty lower lobe.
2. Weights in lower lobe assume empty main deck.
3. Combined main deck/lower lobe weights cannot exceed main deck limits on a vertical plan (i.e., 14,000 lbs on pp 18+3 limits LL plt 2 to 4,000 lb).



△ Since pp 18 & 3 and lower lobe pp 2 are in a vertical plane, combined pallet wts cannot exceed main deck max (18,000 lb).



* 100F SIDE DOOR ONLY
200C HIDE DOOR ONLY
200F HIDE & SIDE DOOR



The main deck of the B-747 can be configured for a 33 or 37 military pallet configuration. The 33 pallet configuration is required for mixed loads or loads made up entirely of rolling stock. All military cargo on the main deck will be palletized or placed on a palletized subfloor.

The B-747-100F has side door only loading for the main cargo area. The B-747-200C may have visor door only loading or both visor and side door loading for the main deck. The B-747-200F has a nose cargo door with an optional side cargo door. The visor and side doors are about 16 feet AGL and require other than standard military MHE.

The upper area directly behind the crew compartment may be included for military planning purposes for passengers on a select basis. Seating availability (0 to 32) depends on the model and configuration.

The lower deck or lobe has three sections. The forward lower lobe can carry five military or commercial pallets; the center lower lobe, four military or commercial pallets; and the lower lobe aft bulk area, approximately 800 cubic feet of bulk cargo. The lower lobes can also carry eight full-sized cargo containers (186 by 60.5 by 64 inches) in the forward section and seven in the aft section. A removable net separates the bulk cargo area from the lower lobe aft compartment.

CAUTION

No hazardous cargo or equipment can be placed in the center lower lobe or aft bulk compartment. These compartments are inaccessible during flight.

Cargo capabilities vary. Refer to the specific aircraft series. For general planning purposes, refer to Figure 3-7 for pallet weight limitations. For the forward and aft lower lobes, cargo must be palletized, put on a pallet subfloor, or containerized. The bulk area is normally used for baggage or light cargo and therefore would not require a subfloor.

The lower lobes normally have rails ready to accept a commercial pallet. If the rails cannot be readily converted to accept a 463L pallet, laterally restrain the pallet by securing it with a chain bridle to the left rail. Secure cargo with straps or chains. Installing end locks provides forward, aft, and vertical restraint.

DC-8

The DC-8 is a four-engine, long-range, narrow-body aircraft (Figure 3-8). It can carry 165 to 252 passengers or up to 110,000 pounds of cargo. Variations depend on aircraft series, spacing of the seats (Figure 3-9), and individual aircraft configurations. The main deck of the DC-8 can receive from 14 to 18 military 463L pallets (Figure 3-10) depending on the aircraft series.

The aircraft rail system can accept 125-inch-wide commercial or 108-inch-wide military pallets. Both side cargo rails may be moved inboard 8.5 inches to allow centerline loading of the 108-inch military pallet and the 125-inch commercial pallet in the same load. The aft-most pallet must have the 88-inch side facing the front or aft section of the cargo compartment.

All military cargo on the main deck will be palletized or placed on a palletized subfloor. For general planning purposes, use the maximum weight limitations in Figure 3-10. The side door to the main deck is about 11 feet AGL; therefore, standard military MHE (except the TAC loader) can load items on the main deck.

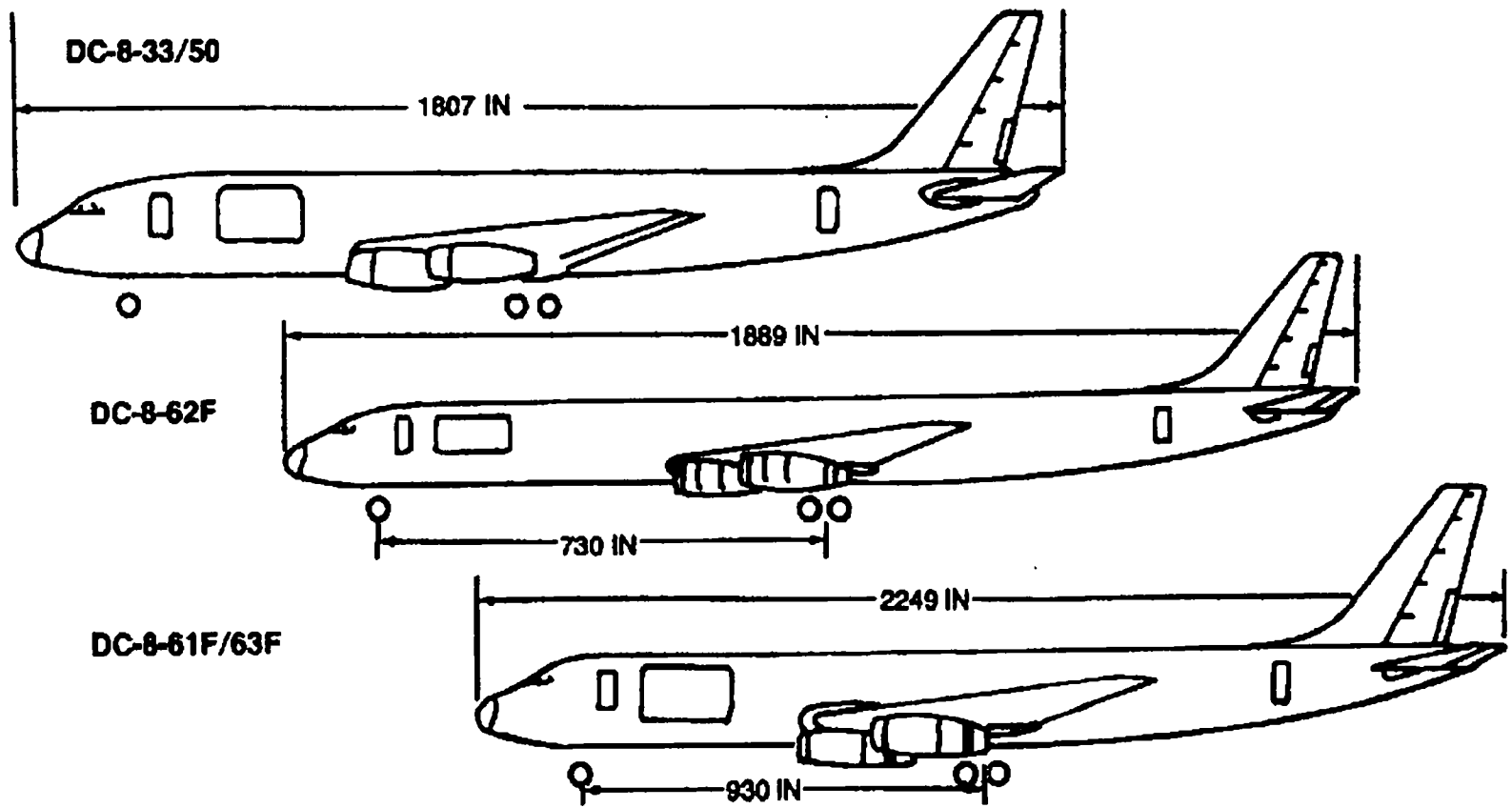
The lower lobes (Figure 3-11) have a lower forward compartment, a lower aft compartment, but no aft bulk cargo area. The size of the compartments varies according to the series. The forward and aft lower compartments have two cargo doors into each compartment (except for the DC-8-33, which has only one door to each compartment).

Because of door restrictions, pallets cannot be used as a subfloor. Therefore, the lower compartments are usually loaded with small hand-transportable cargo items or baggage.

NOTE: The cargo version DC-8 may settle on its tail section if loaded improperly. Before loading the main cargo compartment, position about 5,000 pounds of cargo in the forward area of the main deck, pallet position 1, or in the forward lower compartment.

For passenger aircraft, 40 percent of the baggage weight should be in the forward lower compartments and 60 percent in the aft lower compartments. As with most commercial aircraft, loading the lower forward compartment before loading the aft compartment is preferred.

Figure 3-8. DC-8.



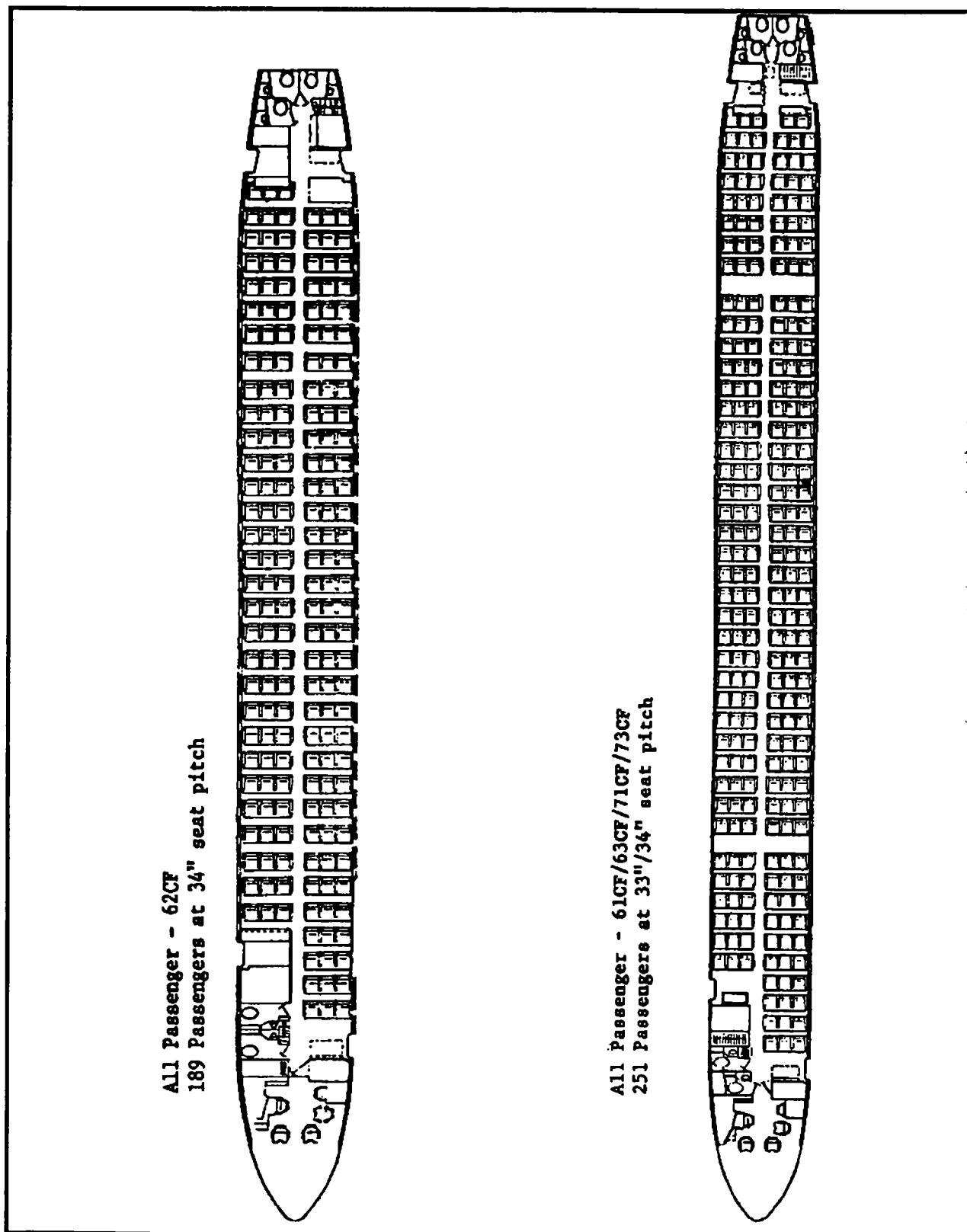


Figure 3-9. DC-8 Typical Passenger Arrangement.

DC-8-62F/CF



DC-8-61CF/-63F/CF and DC-8-71CF/-73F/CF

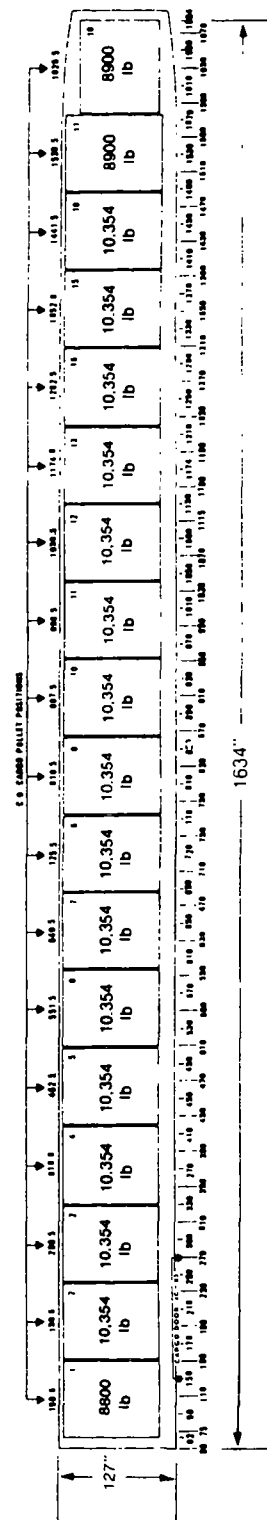
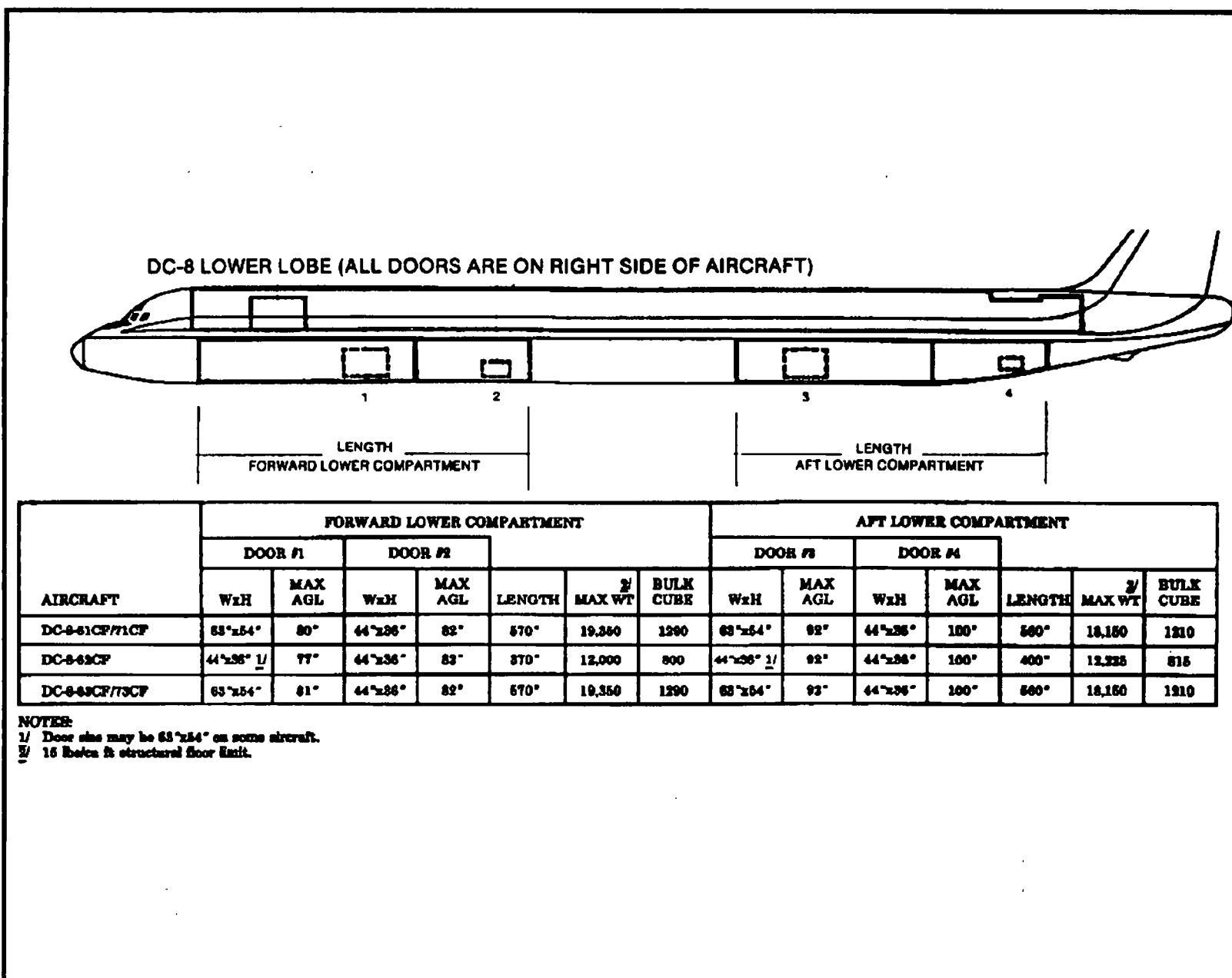


Figure 3-10. DC-8 Main Deck and Maximum Pallet Weights.

Figure 3-11. DC-8 Lower Lobes.



DC-10

The DC-10 is a wide-body tri-jet aircraft (Figure 3-12). It can carry 380 passengers (Figure 3-13) or 176,000 pounds of cargo. The actual passenger and cargo capability varies based on aircraft series and configuration.

The main deck of the DC-10 can hold 30 military 463L pallets. All military cargo on the main deck must be palletized or placed on a palletized subfloor. For general planning purposes, use the maximum weight limitations in Figure 3-14. The side door to the main deck is about 16 feet AGL and therefore requires other than standard military MHE.

The DC-10 has three lower lobe compartments (Figure 3-15). The forward lower lobe has a solid floor. Either 1,300 or 3,045 cubic feet are available, depending on the galley location either up or down. Some aircraft have 463L pallet capability, depending on the cargo door size (Figure 3-16). The center lower lobe has a solid floor. It has either the standard 1,550-cubic feet capability or the extended center lower lobe of 1,935-cubic feet capability. The aft bulk compartment has a solid floor. Most DC-10s have the standard 805-cubic feet capability. If the center lower lobe is extended, the aft bulk compartment is 510 cubic feet.

For passenger DC-10s, start loading baggage in the aft bulk compartment, then the center lower lobe, and finally the aft section of the forward lower lobe. For cargo aircraft, load bulk cargo designated for the forward lower lobe first, then pallet

positions 1 left and 1 right on the main deck, and finally the remainder of the main deck from the aft section forward and the center lower lobe/aft bulk compartment.

L-1011

The L-1011 is a long-range, wide-body, tri-jet passenger aircraft (Figure 3-17). Only the passenger model is now available for military use. The L-1011 is normally configured to carry 246 to 330 passengers. Variations on passenger seating availability depends on the aircraft series, the location of the galley, and spacing requirements of the seats (Figure 3-18).

The lower lobe (Figure 3-19) has a forward compartment, a center compartment, and an aft bulk loading compartment, each with a single door. The size of these compartments and access doors varies with aircraft model and series. The L-1011-100 has the galley either in the lower lobe or in the main deck cabin.

The L-1011 has no restraint mechanisms to secure 463L pallets. Plan to bulk load or use LD-3 containers (Figure 3-2) in all applicable compartments.

The L-1011 forward lower lobe can accommodate either 8, 12, or 16 LD-3 containers (Figures 3-20 and 3-21), depending on the model series and storage configuration for small-density cargo and passenger baggage. The center lower lobe can accommodate either 7 or 8 LD-3 containers, depending on the model series and configuration. The aft bulk compartment is limited to bulk cargo/baggage only.

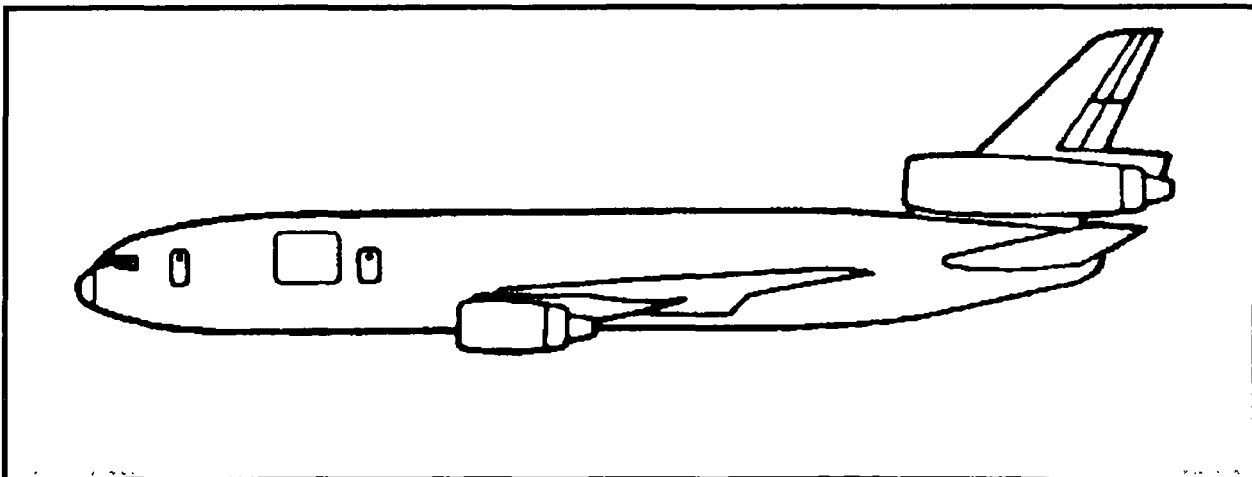


Figure 3-12. DC-10.

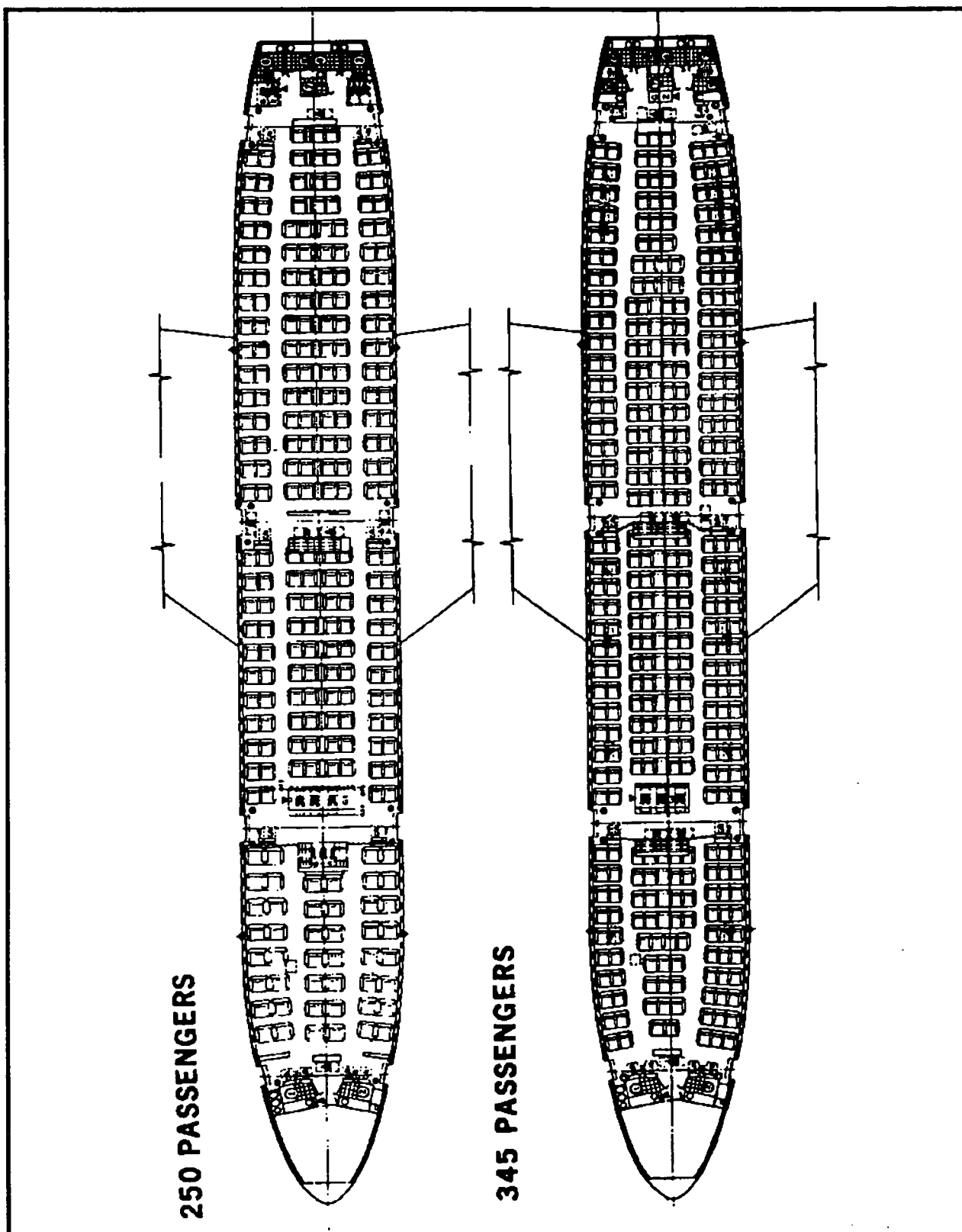
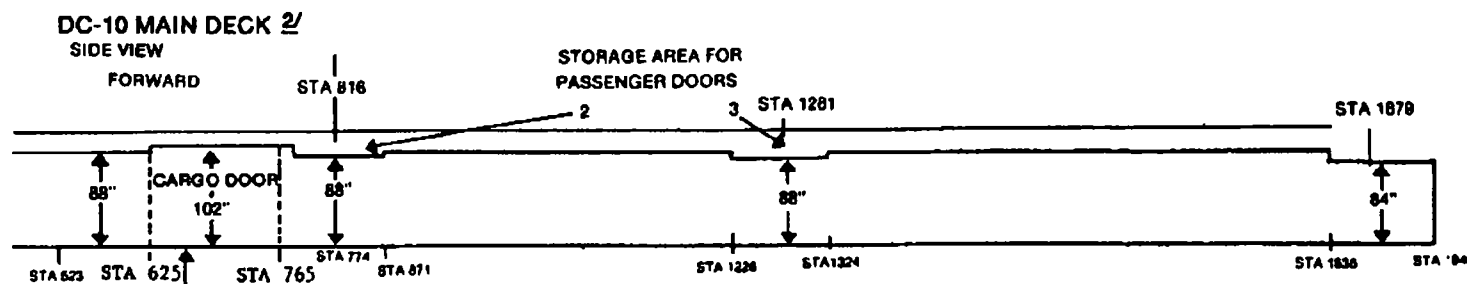


Figure 3-13. DC-10 Typical Seating Arrangement.

Figure 3-14. DC-10 Maximum Pallet Weights and Main Deck Loading Information.

DC-10 MAXIMUM PALLET WEIGHTS ^{1/} AND MAIN DECK LOADING INFORMATION



DC-10-10F/CF -30F/CF

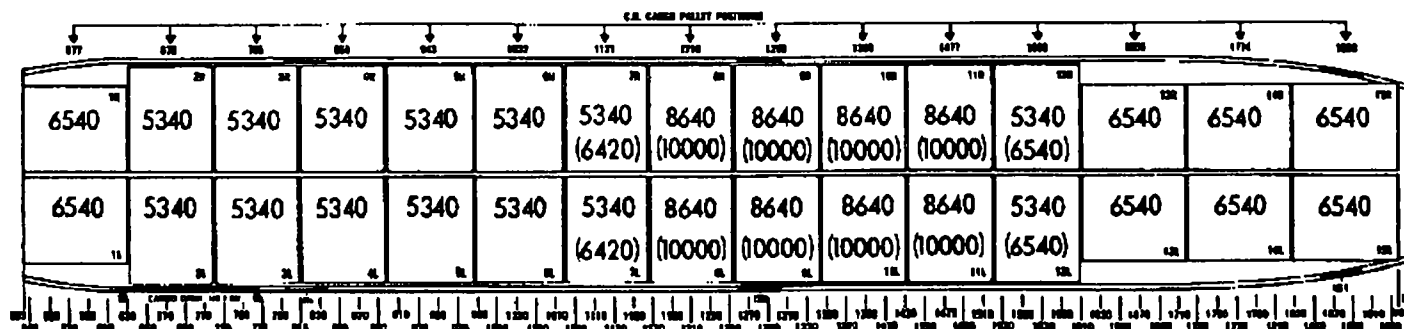


Figure 3-15. DC-10 Lower Lobes.

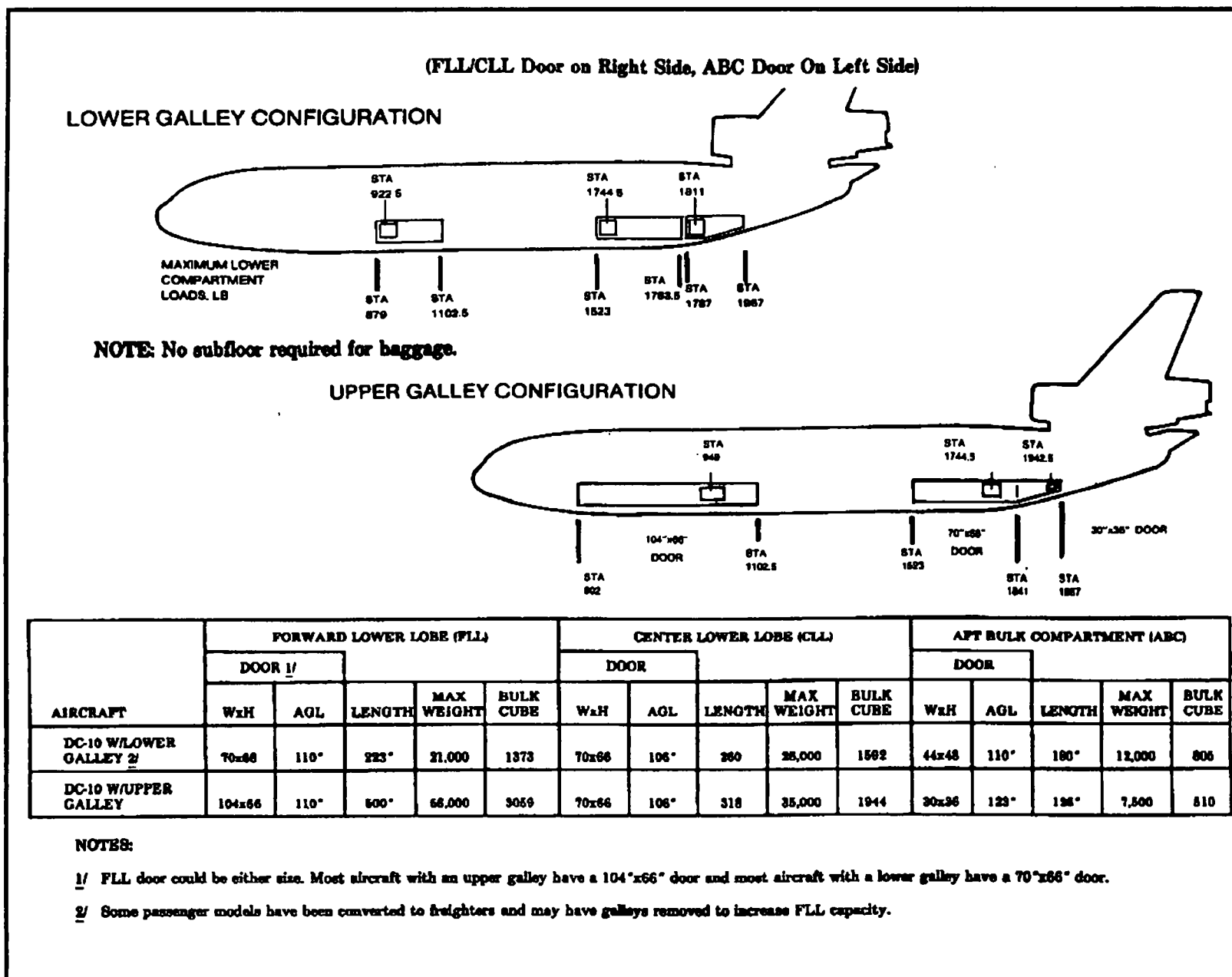
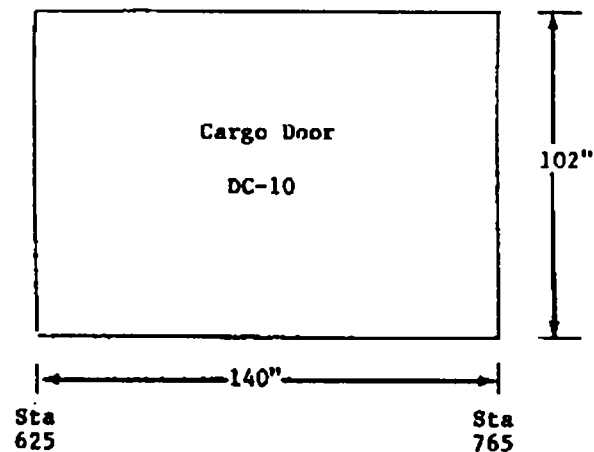


Figure 3-16. DC-10 Side Door Dimensions/Cargo Restrictions.

DC-10 Side Door Dimensions/Cargo Restrictions



Cargo door maximum height calculation:

Door Height	102"
(-) Roller Height	1 3/4"
(-) Pallet Height	2 1/4"
(-) Top Clearance	2"

Maximum Height 96"

NOTE: This is the maximum height only between Stations 624 and 774.

"A" Max Length Chart DC-10 Door 140"x102"—push cargo forward from the door.

		PACKAGE WIDTH (INCHES)										
LENGTH		12	24	36	48	60	72	84	96	108	120	132
PACKAGE HEIGHT (INCHES)	12	340	329	324	317	310	300	278	283	275	252	228
	24	340	329	324	317	310	300	278	283	275	252	228
	36	340	329	324	317	310	305	278	283	275	250	226
	48	330	328	323	316	310	305	278	283	274	248	224
	60	326	321	316	310	305	300	284	285	261	229	218
	72	318	312	307	305	300	297	288	264	244	226	211
84	308	303	297	293	285	285	263	243	227	213	202	

"B" Max Length Chart DC-10 Door 140"x102"—push cargo aft from the door

		PACKAGE WIDTH - INCHES										
LENGTH		12	24	36	48	60	72	84	96	108	120	132
PACKAGE HEIGHT (INCHES)	12	1323	1000	730	578	478	402	350	311	280	252	229
	24	1323	992	730	578	478	402	350	311	280	252	229
	36	1323	982	725	572	472	400	349	308	277	250	228
	48	1266	900	675	542	452	390	341	303	275	247	225
	60	1016	750	582	482	410	359	318	284	261	242	221
	72	800	610	500	425	366	326	288	261	243	224	204
	84	620	500	420	363	324	283	256	241	227	202	184

Maximum package charts for DC-10 side door for cargo pushed forward (Chart "A") and aft (Chart "B") from the door (Example: A package 60 inches high and 48 inches wide loaded toward the aft of the aircraft (Chart "B") can be up to 482 inches long and fit into the cargo area). Longer vehicles can be loaded due to the variable shape.

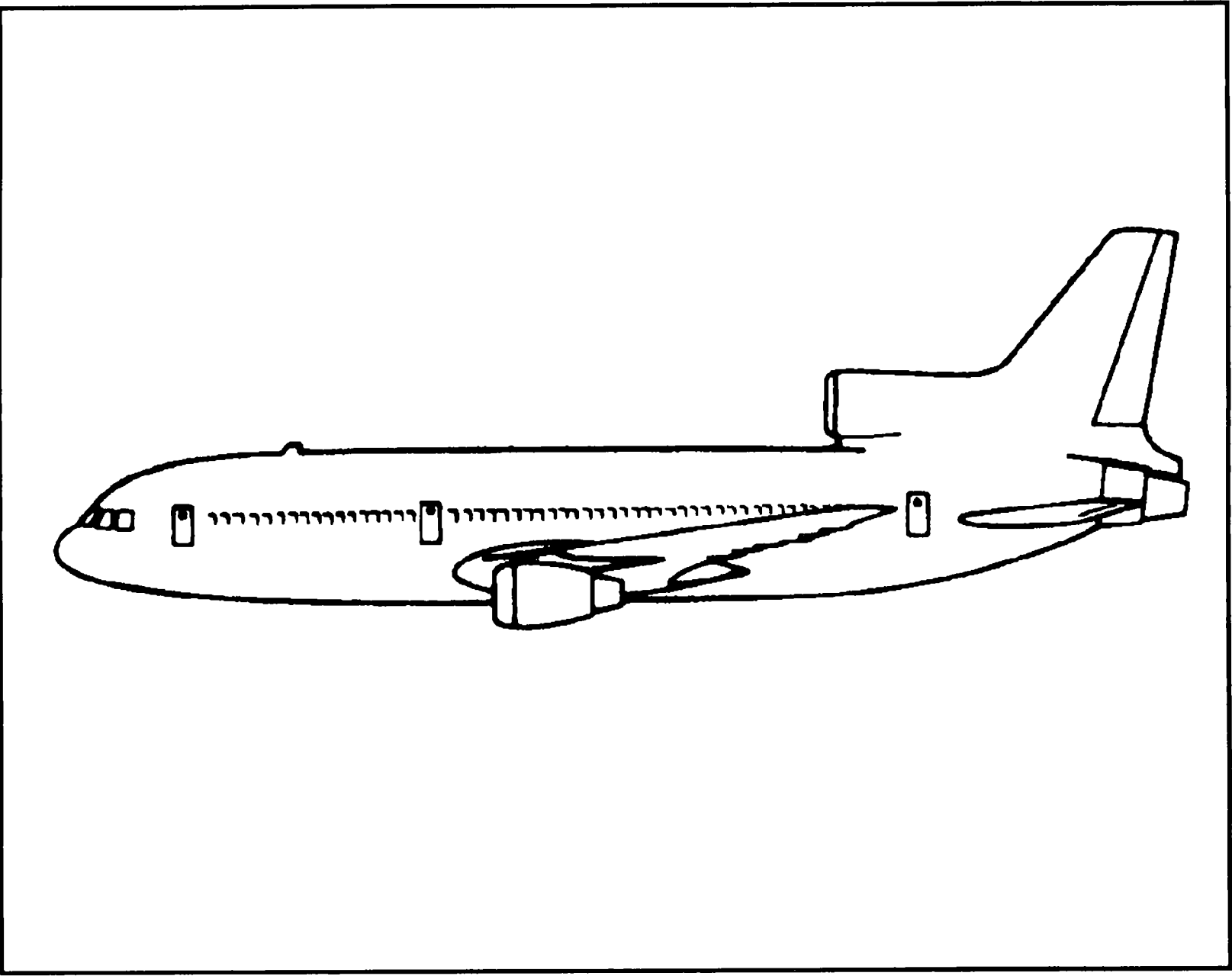
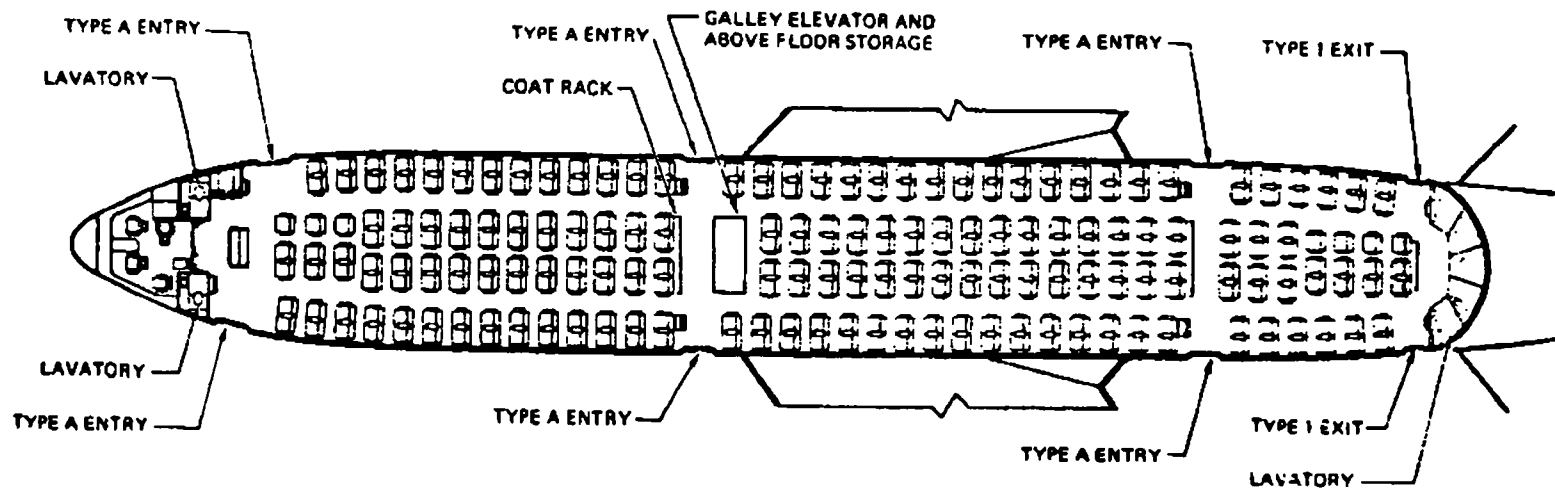


Figure 3-17. L-1011.

MODELS L-1011-1/-100/-200
(279 SEATS, ALL COACH)



MODEL L-1011-500
(270 SEATS, ALL ECONOMY)

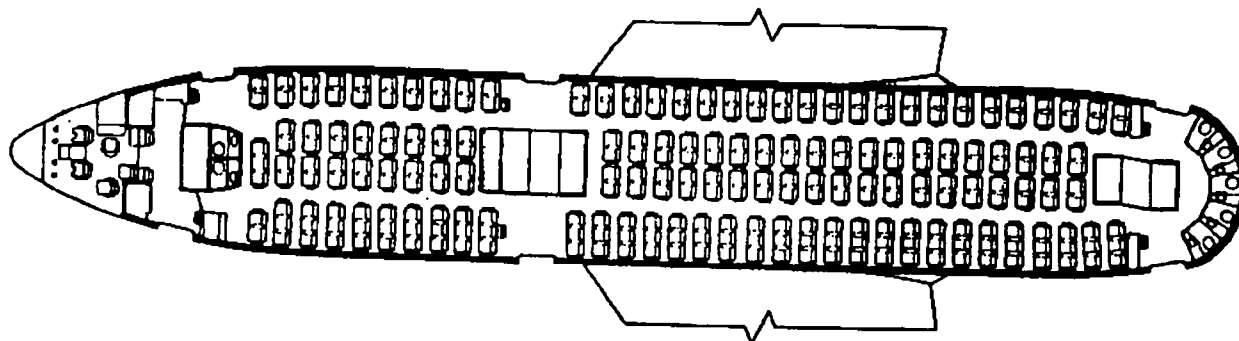


Figure 3-18. L-1011 Typical Seating Arrangements.

Figure 3-19. L-1011 Lower Lobes.

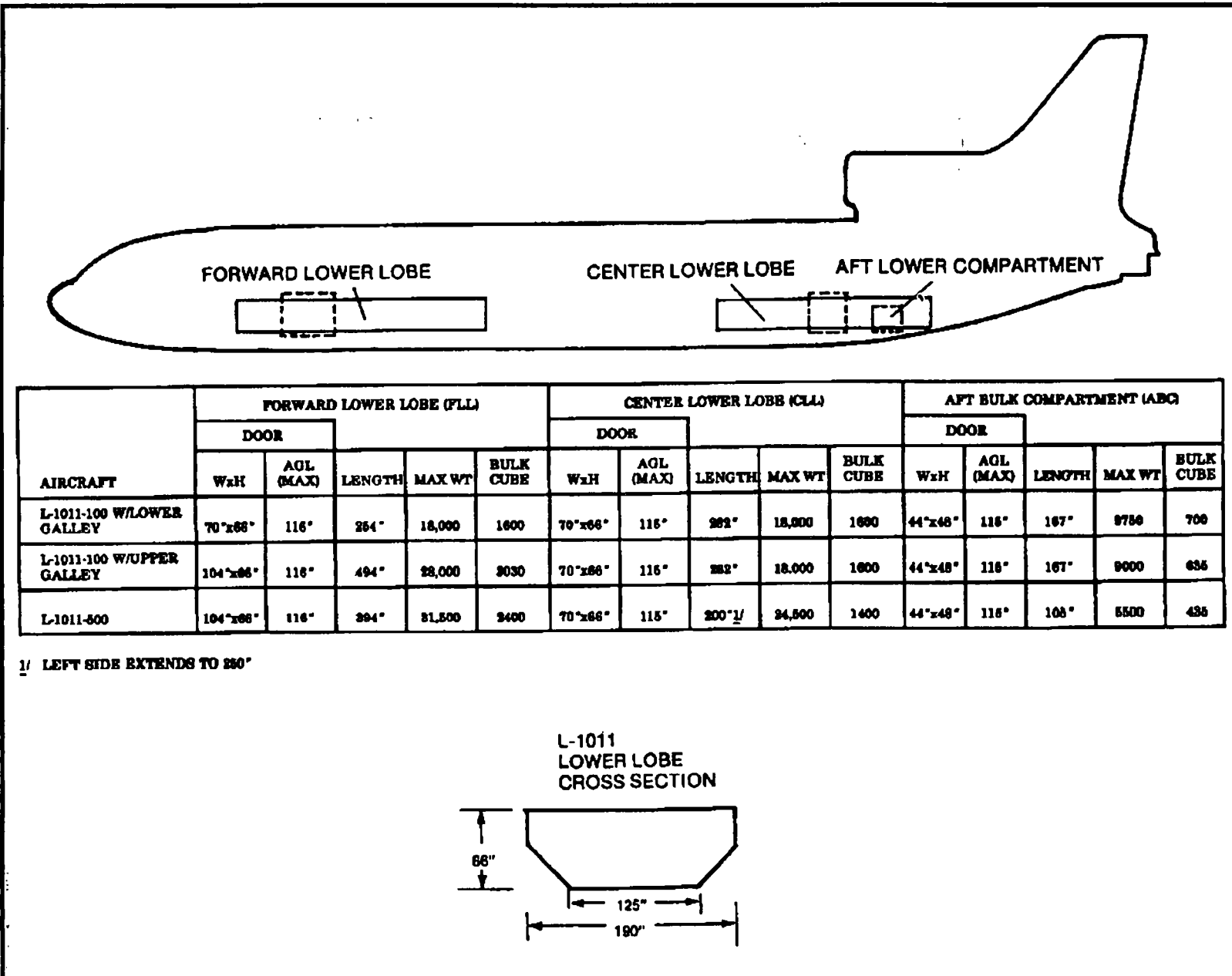


Figure 3-20. L-1011 (with Main Deck Galley) Baggage Containers.

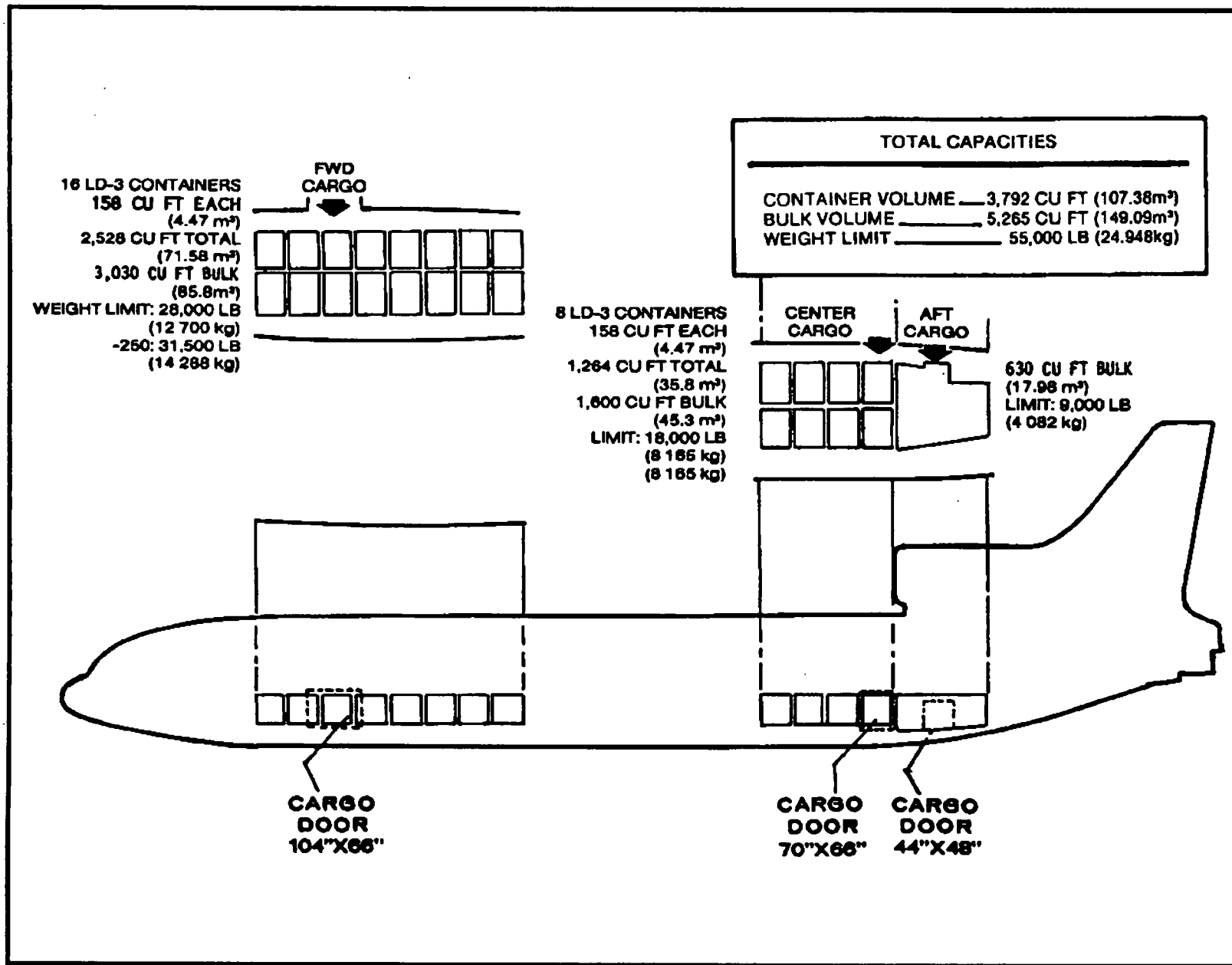
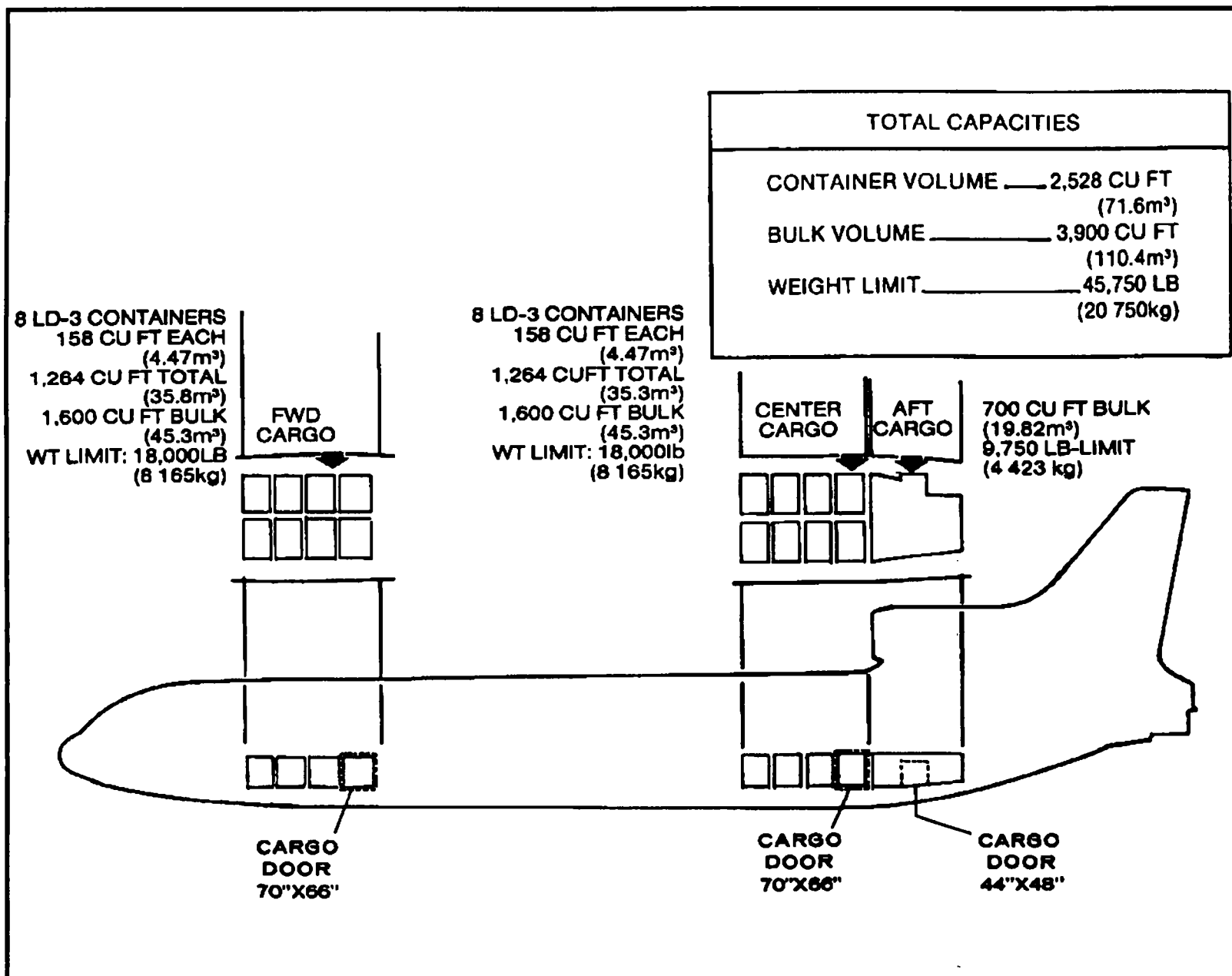


Figure 3-21. L-1011 (with Lower Lobe Galley) Baggage Containers.



CHAPTER 4

UNIT AIR MOVEMENT PLANNING GUIDELINES AND CONSIDERATIONS

INTRODUCTION

This chapter provides guidelines and considerations to assist the airload planner with the building of a unit movement plan based on the commander's guidance and determination of a tactical or nontactical move.

AIRCRAFT REQUIREMENTS

There are two distinct phases in planning unit movement loads. The first is load planning and the second is manifesting. During the load planning phase, the unit identifies what the airlift requirements are in terms of equipment and personnel. For equipment and personnel preparation, refer to Appendix B. The unit also identifies how many aircraft of each type to use. This phase may be repeated many times to refine the movement or to reduce the total aircraft requirement. During the second phase, load planners complete the final load plan and cargo manifests. The final load plans may differ from the preplanned ones because of changes in unit movement priorities, aircraft scheduling, or equipment.

The first phase identifies the overall requirement in terms of unit equipment and number and type of aircraft. The second phase lets the unit prioritize the movement requirement based on the operational conditions existing at the time of movement.

The unit standing operating procedure (SOP) should specify the order in which personnel, equipment, and materiel will move by air. Planning guidance from higher headquarters will indicate the type of aircraft available for the movement.

Based on this information, the load planner determines and requests the number of sorties, by type of aircraft, required to complete the move. To plan the airlift movement itself, first identify exactly how many personnel and what equipment will move. Second, be aware of the characteristics of the aircraft that will carry the load.

Chapters 2 and 3 provide specific details on aircraft. Technical assistance may be obtained through the supporting airlift wing or through your affiliated ALCS.

Before submitting the request for aircraft, ensure that each aircraft will be used to its maximum capability based on the information that has been developed, including applicable allowable cabin loads and available passenger seats. When ACL and passenger seat availability are not known, use the data in Chapter 2 for advance planning, but remain prepared to make adjustments.

There are three methods of determining aircraft (sortie) requirements. They are the weight method, the type-load method (both manual), and the Automated Air Load Planning System (AALPS) process.

Weight Method

Use the weight method to calculate sortie requirements to transport large amounts of supplies, general cargo, and personnel. This method is based on the assumption that total weight, not volume, is the determining factor. To give a general idea of aircraft requirements for a planned move, high-level planners use the weight method.

Type-Load Method

In any unit air movement, a number of the aircraft loads will contain the same items of equipment and numbers of personnel. Identical type loads greatly simplify the planning process and make the tasks of manifesting and rehearsal much easier. Used for calculating individual aircraft sortie requirements, the type-load method is the most common and most widely accepted method of unit air movement planning. The method requires consideration of load configuration and condition upon arrival at destination, rapid unloading, aircraft limitations, security requirements en route, and the anticipated operational requirements. The type-load method,

therefore, is more detailed and is normally used in planning unit movements.

Automated Air Load Planning System

AALPS uses the type-load method and through automation allows the user to manipulate the data base to build different force packages and options for timely decision making. See Chapter 5 for more information on AALPS.

AIR MOVEMENT PLANNING WORKSHEETS

Two forms used for unit air movement planning are the Air Movement Planning Worksheet and DD Form 2327 (Unit Aircraft Utilization Plan). This manual discusses the Air Movement Planning Worksheet, which is found in Appendix C. DD Form 2327 is explained in detail in Appendix B of FM 55-12.

Air movement planning is an important task that requires close attention to detail and an ability to carefully balance requirements, assets, and priorities. It is in effect a large accounting problem with a series of checks and balances to ensure that all equipment and personnel are moved on time and that all the aircraft are used as the commander's intent directed.

The most important consideration before starting air movement planning is the mission of the unit when it arrives. Filling the aircraft to its safe maximum operating limits is the next most important consideration. Review all of the unit's contingency plans, and check with the unit commander and the operations officer for additional guidance. Frequently, the commander will have specific mission requirements. The mission may determine the type of aircraft used. If it is a short-range mission with small amounts of heavy equipment or an operation into a forward tactical area, the C-130 aircraft may be the transport. A long-distance deployment, with a large amount of heavy equipment, could require use of the C-141 or C-5 aircraft.

Once the mission is known, movement plans must include all units, personnel, equipment, and materiel to accomplish the mission. Using information in Chapter 5, load all the vehicles with as much unit equipment as possible without exceeding the cross-country weight capacity of the vehicle. Ensure that all cargo is properly secured in the cargo compartment of the vehicle. Measure and weigh the vehicles after they are loaded. Guidance for weighing and marking the vehicles is in Appendix G of FM 55-12 and AR 220-10. Review FM 55-65 for tactics, techniques, and procedures on how to load and lash vehicles.

Using the unit table of organization and equipment/modification table of organization and equipment (TOE/MTOE) as a guide, start the Air Movement Planning Worksheet with the first element. When planning a tactical move, maintain as much unit integrity as is consistent with the principles of aircraft use. Fill in the weight and dimension data, including the cargo weight of the vehicles carrying cargo. Before going on to anything else, complete the worksheet. Very rarely will the load plan of the aircraft be in the same order in which the elements appear on the Air Movement Planning Worksheet. See Appendix C for instructions on how to complete this form.

Once the Air Movement Planning Worksheet is completed, the next step is to complete DD Form 2327. Refer to Appendix B of FM 55-12 for complete guidance on filling out this form.

The final step after completing the Unit Aircraft Utilization Plan is to prepare the cargo manifests. Using the DD Form 2130-series cargo manifest forms (DD Form 2130-1 [C-5A/B], DD Form 2130-2 [C-130], and DD Form 2130-3 [C-141B]), plan the placement of each vehicle and item of equipment. Refer to Appendix B of FM 55-12 for complete guidance on filling out these forms. Chapter 5 outlines the specific details for load planning of individual aircraft.

CHAPTER 5

BASICS OF AIRCRAFT LOAD PLANNING**INTRODUCTION**

This chapter shows how to carefully plan an air movement to ensure efficient use of the aircraft before loading. It concentrates on the manual air load planning method but also discusses automation. Air load planners must be proficient in manual air load planning techniques before using automated methods.

The following basic principles of load planning apply to any type of aircraft. Load planning—

- Identifies the type of aircraft needed to carry a load.
- Identifies the exact number of aircraft needed to accomplish a particular mission.
- Identifies in advance any additional required loading aids to ensure availability at load time. Aircraft ground time is minimized when the unit is prepared to load.
- Helps the unit prioritize the movement of cargo and personnel.

Many factors are considered in the load planning process. Primarily, the load planner must ensure the safe and efficient use of the aircraft. The load planner must comply with aircraft safety, weight and balance, and floor load restrictions. The load must be within an acceptable center of balance condition for takeoff, flight, and landing. The load planner must also consider the ease of loading and unloading. Improper planning can result in excessive loading or unloading time or structural failure in flight or on landing. A load properly planned and coordinated will go on the aircraft quickly, safely, and with minimum difficulty.

LOAD PLANNING CONSIDERATIONS

Some basic considerations affect the aircraft and aircraft stability. The following must be known before any load planning can begin:

- The aircraft critical leg allowable cabin load.
- The center of gravity range of the aircraft.

- * • The placement of the cargo in the aircraft so that the weight and balance check will not require rearranging of the cargo. Usually the heaviest items of cargo are placed in the aircraft CG area, with the lighter items forward and aft. See Table 2-1 for CB windows.
- The location of the emergency exits. Cargo should not block any passenger or emergency door.
- The location of the safety aisle. Cargo should never obstruct the required safety aisle that lets the crew move freely from the front to the rear of the aircraft.
- The cargo loading order. The cargo scheduled to be unloaded first is usually loaded last.
- The requirement for hazardous cargo marking, documentation, and placement within the aircraft. Each unit is responsible for certification of hazardous material and specific packaging requirements according to TM 38-250.

Other load planning considerations relate directly to the deploying unit: its mission and the expected scheme of operation upon arrival at destination. FM 55-12 details planning considerations and responsibilities.

TYPES OF LOADS

Aircraft loading is generally categorized into two types: concentrated loading and palletized loading.

Concentrated Loading

Concentrated loads are very large or heavy items, such as vehicles, tanks, or construction equipment. The precise station location on which the cargo is to be placed inside the aircraft must be computed. To properly place the cargo on a specified station, the cargo item must be marked with the correct center of balance. Since station

computations enter into this method of loading, it is also called station loading.

Palletized Loading

The entire aircraft load generally consists of preloaded 463L pallets, properly secured and ready for flight. The center of each pallet is its center of balance unless the pallet is marked otherwise. The 463L restraint rail system positions and secures the pallets in the aircraft. See Appendix D for more information on the 463L cargo system.

AIRCRAFT LOADING DATA

The unit load planner must be familiar with the loading rules and limitations for each aircraft. General rules that apply to all aircraft follow:

- Plan to move general bulk cargo, such as boxes or crates, on the back of cargo-carrying trucks or trailers. Stacked bulk cargo should not exceed the reduced configuration height of the cargo-carrying vehicle according to TB 55-46-1. Ensure vehicle weights used for load planning include the weight of the cargo.
- Secure all general bulk cargo with a minimum of 1/2-inch diameter rope. Hemp rope is recommended; nylon is not authorized.
- Use only forklifts rated at a lifting capacity equal to or greater than the cargo being loaded. Normally, 10K forklifts, all terrain/rough terrain (AT/RT), are used.
- Use forklifts with a minimum tine length of 72 inches to avoid dropping or damaging the 463L pallet.
- Use a minimum of 3/4-inch shoring when loading tracked vehicles with metal cleats, studs, or other gripping devices that will damage the aircraft floor. See Chapter 6 for more information on shoring.
- Do not deflate vehicle tires to achieve vehicle height clearance to fit within the aircraft loading envelope.
- Treat tires with over 100 psi as hard rubber tires; consider floor limitations.

- Do not use the book weight or item data cards for weight and balance purposes during actual airlift. Use the actual scale weight.

*Another consideration when planning loads for the C-130, C-141, and C-17 is that neither has a separate troop compartment. Therefore, when planning troop movements, cargo-carrying capacity is sacrificed. The cargo load restricts the number of troops that can be carried. The following general rules apply to the use of sidewall seats when planning nonpalletized cargo on the C-130, C-141, and C-17:

- * • Cargo widths up to 76 inches for the C-130, up to 80 inches for the C-141, and up to 156 inches for the C-17 - may carry troops on both sides of the cargo. Centerline load the cargo in the aircraft.
- * • Cargo widths of 77 inches to 96 inches for the C-130, 81 inches to 96 inches for the C-141, and 157 inches to 192 inches for the C-17 - may carry troops on one side of the cargo only. Cargo will be offset to the right side of the cargo compartment.
- * • Cargo widths over 96 inches for the C-130, C-141, and over 192 inches for the C-17 - no troops will be seated beside the cargo. Centerline load the cargo in the aircraft.

PRINCIPLES OF MOMENT

To understand center of balance considerations, it is necessary to understand the principles of moment. Moment is simply the product of a force (or weight) times the distance from the reference datum line. The distance used to calculate a moment is the arm, which is expressed in inches. To calculate moment, a force (or weight) and distance must be known. The distance is measured from some known point (reference point or reference datum) to the point throughout which the force acts. Moment is meaningless unless the reference point about which the moment is calculated is specified.

There are three items used in weight and balance calculations: moment, weight, and arm. The

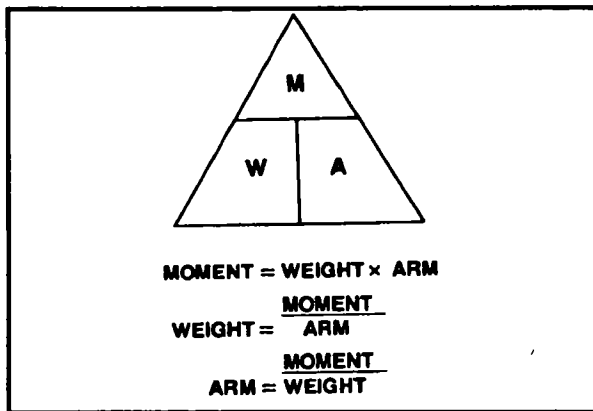


Figure 5-1. Moment—Weight—Arm Triangle.

relationship of these items can be shown by arranging them in a mathematical triangle (Figure 5-1).

Perhaps the simplest way to explain this is to look at a child's seesaw: A heavy board is placed across a fixed support about which the board balances (fulcrum). When there are two different size children riding the seesaw, they use their skill or intuition to make it operate properly. They do this by compensating with distance: the heavier child sits closer to the fulcrum and the lighter child sits farther away from the fulcrum.

EXAMPLE 1:

Look at Figure 5-2. A board is perfectly balanced with a 30-pound weight on one end and a 60-pound weight on the other. This example shows that the influence of weight depends directly on its distance from the fulcrum. For balance to exist, the weight must be distributed so the leverages or turning effects are the same on each side of the fulcrum. Note that the heavy weight near the fulcrum has the

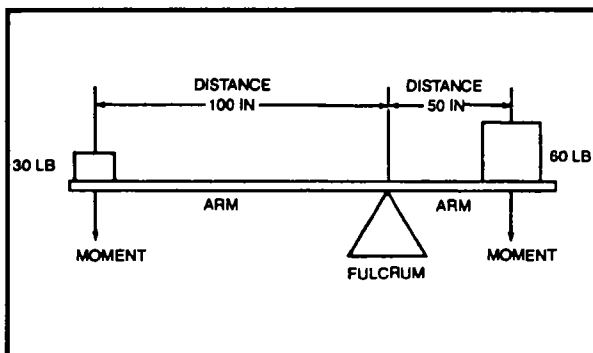


Figure 5-2. Example 1, Balanced Board.

same effect as a lighter weight farther from the fulcrum.

To prove mathematically that the seesaw board is balanced, apply the formula in Figure 5-1 to determine whether or not the moments applied to each side of the fulcrum are equal.

<u>LEFT SIDE</u>	<u>RIGHT SIDE</u>
W = 30 pounds	W = 60 pounds
A = 100 inches	A = 50 inches
M = W x A	M = W x A
= 30 x 100	= 60 x 50
= 3,000 inch-pounds	= 3,000 inch-pounds

Substituting the values from the above example into the formula shows that each side has a moment of 3,000, and the seesaw board is perfectly balanced.

EXAMPLE 2:

If the fulcrum is unknown with the same seesaw board and the same weights as in Example 1, the problem is to determine the location of the fulcrum, or the CB. To find the fulcrum, apply the same formula described in Example 1, but first measure some distances (arm) to find the appropriate moment for each weight. To measure the distance, a specific known starting or reference point is needed. These measurements may be made from any point, but in this example, the left

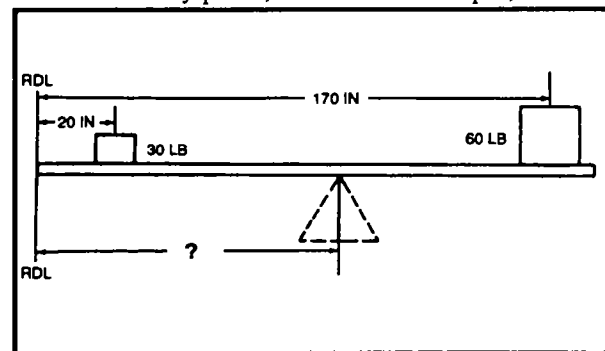


Figure 5-3. Example 2, Unknown Balance Point.

end of the seesaw board will be the reference point or reference datum (Figure 5-3).

Assume the distance for each of the weights on the seesaw board from the RD line measured 20 and 170 inches respectively. Note that the

distances are measured from the RD to the center of mass or CB of each of the weights. Using the same formula again, compute the moment:

Weight x Arm = Moment

$$30 \times 20 = 600 \text{ inch-pounds}$$

$$\frac{60}{90} \times 170 = \frac{10,200 \text{ inch-pounds}}{10,800 \text{ inch-pounds}}$$

$$90 \quad 10,800 \text{ inch-pounds}$$

Add the weights and the moments (inch-pounds) as shown above. Now, to find the distance to the center of balance (fulcrum) in this example, divide the total moment by total weight.

$$\frac{\text{Total Moment}}{\text{Total Weight}} = \text{Arm or } \frac{10,800}{90} = 120 \text{ inches}$$

Therefore, the center of balance (fulcrum) of this seesaw board is 120 inches from the RD line (Figure 5-4).

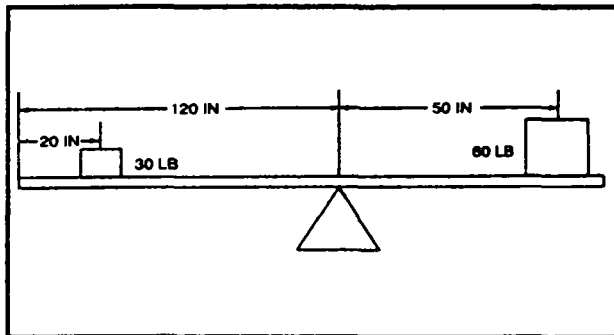


Figure 5-4. Example 2, Balanced Board.

Again to prove mathematically that each side of the seesaw board is subjected to the same moment, and therefore is balanced, calculate as follows:

LEFT SIDE

$$\begin{aligned} A &= 120 - 20 \\ &= 100 \end{aligned}$$

$$\begin{aligned} M &= W \times A \\ &= 30 \times 100 \end{aligned}$$

$$= 3,000 \text{ inch-pounds}$$

RIGHT SIDE

$$\begin{aligned} A &= 170 - 120 \\ &= 50 \end{aligned}$$

$$\begin{aligned} M &= W \times A \\ &= 60 \times 50 \end{aligned}$$

$$= 3,000 \text{ inch-pounds}$$

Since the same moment or leverage (3,000 inch-pounds) is applied to each side, the seesaw board is balanced.

LOAD CENTER OF BALANCE

In some older publications, the term center of gravity or CG is widely used with aircraft loads (cargo). This term is the same as load or cargo center of balance. Since balance of the aircraft is mainly affected by weight variations along the longitudinal axis of the cargo inside the aircraft, the term center of balance more appropriately refers to the balance point of items of cargo or equipment that go into the aircraft.

For general cargo center of balance computation and vehicle center of balance computation, refer to Appendix G of FM 55-12.

For load center of balance computation, decide what goes on each aircraft; then compute the total load weight and balance to ensure that the load is within aircraft limits. To do this, know the—

- Weight of each vehicle or piece of equipment.
- Fuselage station CB of each vehicle or piece of equipment as it is located within an aircraft.
- Total cargo center of balance limitations range of the aircraft.

The formula to find the load CB is the same as described in the previous two examples. To find the arm, the final CB of the loaded aircraft, add all the weights and moments of the cargo. Then divide the total moment by the total weight to get the final CB (Figure 5-1). If that CB is within limits (CB limitation range) for that aircraft, the load is acceptable. If the CB is not within CB limits of the aircraft, then move or resequence some of the cargo items and recalculate.

EXAMPLE:

A C-141B load with the weights and fuselage stations shown in Table 5-1 has been developed.

*The final CB of this aircraft load is 940. The cargo load center of balance limits (floating window) is in Table 2-1. The CB limits of a C-141B with a 50,000-pound cargo load is from 880 to 950. So this load is acceptable and will not endanger the aircraft.

Table 5-1. Example C-141B Load.

<u>ITEMS</u>	<u>WEIGHT</u>		<u>FUSELAGE STATIONS</u>		<u>MOMENT</u>
4 troops - 210 pounds each	840	x	398	=	334,320
M105A2 trailer, 1 1/2-ton	4,400	x	470	=	2,068,000
M35A2 truck, 2 1/2-ton	16,700	x	700	=	11,690,000
M149A1 trailer, water	2,500	x	900	=	2,250,000
M35A2 truck, 2 1/2-ton	14,200	x	1,140	=	16,188,000
463L pallet, cargo	5,860	x	1,371	=	8,034,060
463L pallet, cargo	<u>2,340</u>	x	1,472	=	<u>3,444,480</u>
Total Weight 46,840			Total Moment 44,008,860		
$\frac{\text{Moment}}{\text{Weight}} = \text{CB Arm of Load}$			$\frac{44,008,860}{46,840} = 939.5 = 940$		

On most aircraft loads, personnel weight and arm must be included in the aircraft load computation. Personnel should be seated all together (rarely will all available seats be filled) and their CB should be figured from the fuselage station closest to the center of the mass.

Whenever possible, seat personnel in directly opposite seats. If personnel seats are staggered on either side of the aircraft or in no particular pattern, the CB of each group must be included. The closer together personnel are seated in the aircraft, the fewer computations must be done to determine the aircraft CB.

Loaded pallets do not need a separate CB measurement and marking unless they are of unusual configuration. The loaded pallet must be part of the load CB computation, but the fuselage stations for the pallets are identified in the aircraft and along the top of the DD Form 2130-series cargo manifest forms. Pallets should not be placed on any other fuselage station except those so identified.

PLACEMENT OF AIRCRAFT LOADS

Load Planning

Boxes, crates, pallets, and other relatively small items are easy to load into an aircraft but still require a plan on how and where they should be placed inside the aircraft. Wheeled vehicles, trailers, tracked vehicles, and other large equipment require much greater planning effort.

The development of an aircraft load requires precision and a knowledge of the principles of center of gravity and balance. Once these principles are understood, aircraft loads can be easily and quickly planned without complicated mathematics.

Place the center of balance of the heaviest item at the optimum CG station of the aircraft. Place the next heaviest item forward of the first item, the third item aft of the first, and so on. This is the pyramid method of loading. It is used to quickly plan the placement of vehicles and other heavy equipment onto the aircraft. One exception to this method is trailers with prime movers. Keep the associated trailer connected to its prime mover for ease of unloading.

Verify the estimated plan after deciding the fuselage station on which to place the equipment. Using this method, together with the templates of the aircraft plans, aircraft loads can be quickly changed or reconfigured without time-consuming figuring.

Templates

The best way to plan load placement manually is to obtain templates of all the vehicles and equipment in the unit. Figure 5-5 shows some sample equipment templates and their placement on a cargo manifest. See Appendix E for more information on templates.

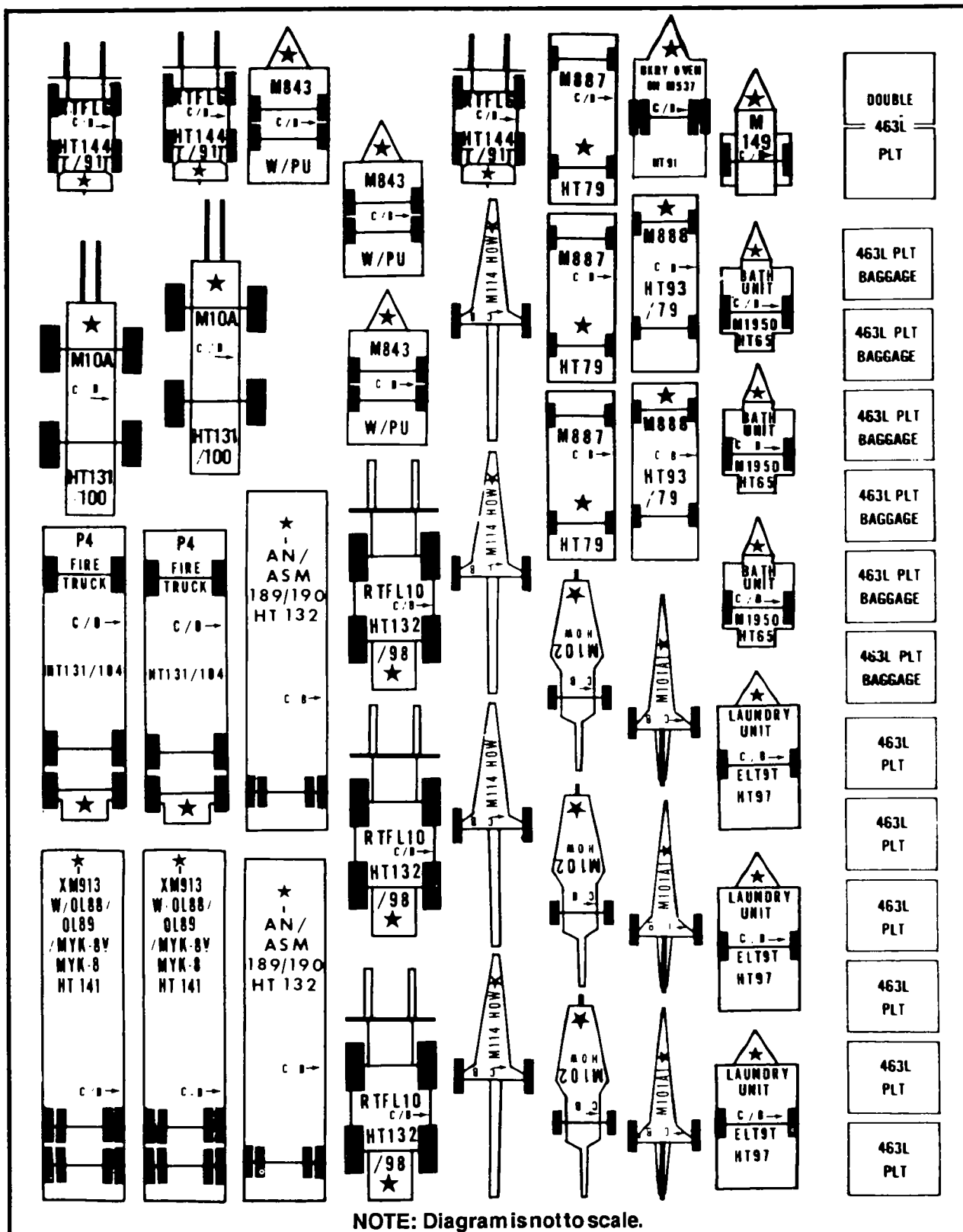


Figure 5-5. Sample Equipment Templates.

Loading Procedures

A large variety of cargo and equipment can be transported by aircraft. Thus, a variety of loading techniques is possible. The ultimate decision of how cargo is to be loaded and positioned aboard an aircraft is an Air Force responsibility, specifically, the aircraft loadmaster. The deploying unit normally does the loading, assisted as necessary by the Arrival/Departure Airfield Control Group (A/DACG) personnel and equipment. However, prior planning is the key. Aircraft load planning is the moving unit's responsibility.

The 55-series transportability technical bulletins provide guidance on loading specific items of equipment or systems. TB 55-45 is an authenticated source of information regarding military equipment certified for transport in Air Force and CRAF aircraft. It also helps as a reference for air movement planning and operations at all levels of command. TB 55-46-1 and -2 (microfiche) define vehicle dimensions and weights for all Army equipment in operational and reduced (shipping) configuration. All deployment planners should refer to these publications during unit deployment planning.

NOTE: In executing unit deployments, actual dimensions and weights must be used.

Follow the prescribed procedures for loading a particular item of equipment. If there are any problems, the loadmaster assigned to the aircraft is the final authority for solving them. Depending on the type of cargo or equipment to be loaded, there may be more than one single method to use. Some of the loading methods follow.

Direct Loading from Vehicles. A vehicle delivers cargo directly to the aircraft. The vehicle is positioned close to the aircraft ramp door, permitting direct transfer of the cargo from the vehicle to the aircraft cargo compartment.

Drive-in/Drive-off Method. The vehicle or prime mover is driven or backed under its own power into the aircraft cargo compartment. This method is generally the easiest for loading vehicles and is also used for vehicles with towed loads and for tractor-trailer units.

Towed Loads. Certain loads, such as trailers, must be towed or backed aboard the aircraft either

by a prime mover or by manhandling. If the towed load remains with the prime mover aboard the aircraft, the trailer may or may not remain hitched to the prime mover inside the aircraft. To conserve space, the trailer may be uncoupled. In that case, the tongue is normally lowered on the aircraft floor under the prime mover and placed on parking shoring.

NOTE: Take care to ensure that proper shoring is placed under the tongue to prevent damage to the aircraft floor.

Pushed Loads. Some loads may be pushed aboard the aircraft either by manhandling or by a pusher vehicle. This method is particularly helpful in pushing large trailers aboard the aircraft because the driver can more easily control the operation. A pusher vehicle must be equipped with a pintle hook that is attached to the front bumper of the vehicle. Standard Army vehicles are not equipped with such devices. A unit may have to fabricate one, using scrap iron and a salvaged pintle hook. See Appendix D for more information on pusher vehicles.

Winched Loads. It may be necessary to winch wheeled or tracked vehicles and skid-mounted or palletized cargo into the aircraft cargo compartment. The winching method is particularly useful where cargo compartment clearances and ramp inclines are critical. The winch is also used to unload cargo or vehicles; it provides necessary restraint and control when the cargo is moved down the aircraft ramp.

Airdrop and Low Altitude Parachute Extraction System (LAPES). For information on LAPES, see FM 100-27.

Loads that Require Materials-Handling Equipment. Several devices are available to ensure rapid loading and unloading of aircraft. Common loading aids provided by the Air Force are the various K loaders (25K, 25K tactical [TAC], and 40K). The 25K loader can accommodate up to three 463L cargo pallets and can carry a maximum of 25,000 pounds. With front and rear extensions installed, the 25K TAC loader can accommodate up to five 463L cargo pallets and can carry a maximum of 25,000 pounds off hard surfaces and 35,000 pounds on hard surfaces. The 40K can accommodate up to five 463L cargo pallets and can carry a maximum of 40,000 pounds. All three are

air- and surface-transportable. In addition to the K loaders, 6,000- and 10,000-pound capacity forklifts supplied by the deploying unit or DACG/TALCE can be used to handle single 463L pallets. See Appendix F for more information on MHE.

AUTOMATION

There are two automated systems available to the airload planner. They are the Automated Air Load Planning System (AALPS) and the Computer-Aided Load Manifesting System (CALM).

AALPS

AALPS is an Army-fielded automated airload planning system that supports deliberate planning and execution phases of air movement as well as force design and analysis. It is currently fielded as a prototype on the Sun 3/140 microcomputer. In FY 93, AALPS software will be converted to a hardware platform based on the 80386/80486 microprocessor and the Unix operating system. In FY 94, it will interface with the Transportation Coordinator-Automated Command and Control Information System (TC-ACCIS) and become a stand-alone module of TC-ACCIS.

AALPS applies to at least three levels of functional users: the unit movement officer (UMO), the deployment planner, and the contingency planner/force designer. AALPS provides "first cut" load plans and the ability to edit/modify those loads for actual deployment. AALPS supports the deployment planner, usually the division transportation officer (DTO), with estimates of airlift requirements for deployment lists and produces output such as load reports, graphic manifests, and force closure estimates. Contingency planners/force designers can determine airlift requirements for numerous force

options or packages for any delivery method and configuration.

Final fielding of AALPS as a module of TC-ACCIS is scheduled for FY 94. Software may become available as early as FY 93. Consult the supporting installation transportation office (ITO) or DTO for current status.

CALM

CALM is an Air Force-fielded automated system used to load plan C-130, C-141, C-5, and KC-10 aircraft. The system uses interactive graphics to help the load planner produce and complete cargo manifests.

CALM is a hard disk-based system requiring a minimum of 2.5 megabytes of disk memory to store the entire program. An additional 2.5 megabytes of disk storage space is recommended to adequately utilize the capabilities of the system. CALM runs on IBM-compatible computers with a minimum of 640 kilobytes (KB) of random access memory (RAM), a CGA or EGA graphics card, a hard disk, one 5 1/4-inch floppy disk drive, and a standard IBM AT keyboard with 10 function keys.

CALM software can normally be obtained through the unit's ITO or DTO. It normally consists of five 5 1/4-inch floppy disks. An additional graphics package, Graphics System Software (GSS) IBM device drivers, Volume 11, is required to run the CALM program. CALM versions newer than 5.0 should no longer require a separate GSS driver system because of different graphics software technology.

Refer to AF Manual 28-346, Volume I/II, the end user manual for CALM, for further information. The Air Force Field Assistance Branch for CALM may be contacted at DSN 596-5771 or commercial (205) 416-5771.

CHAPTER 6

LOAD SHORING

INTRODUCTION

This chapter defines load shoring and assists the load planner in determining when, where, and how much to use. Organizations offering cargo for air shipment must provide shoring. Shoring is lumber, planking, or similar material used to protect the aircraft cargo floor or 463L pallet surfaces. It decreases the approach angle of aircraft ramps, protects airport parking ramps, spreads weight over a larger area, or keeps 463L pallets off the ground. Shoring is very important. It can make the difference between carrying or not carrying a given piece of equipment or load.

Not all AMC aircraft have the same cargo floor pressure limits. Consult your affiliated AMC ALCS for specific loading guidance and remain flexible.

THE NEED FOR SHORING

Although shoring spreads out the weight of a load, the weight of that load is not spread over the entire surface of the shoring. Shoring only increases the area over which a load rests at an angle of 45 degrees from the load contact areas to the surface on which the shoring rests.

Shoring only increases the area of contact by the shoring thickness on all sides of the object resting on it (Figure 6-1). For example, a 2-inch shoring thickness increases the area of contact by 2 inches on all sides of the item resting on it provided the shoring extends at least 2 inches outward around the item being shored. The spreading effect of simple shoring is the same regardless of the shape of the area of contact.

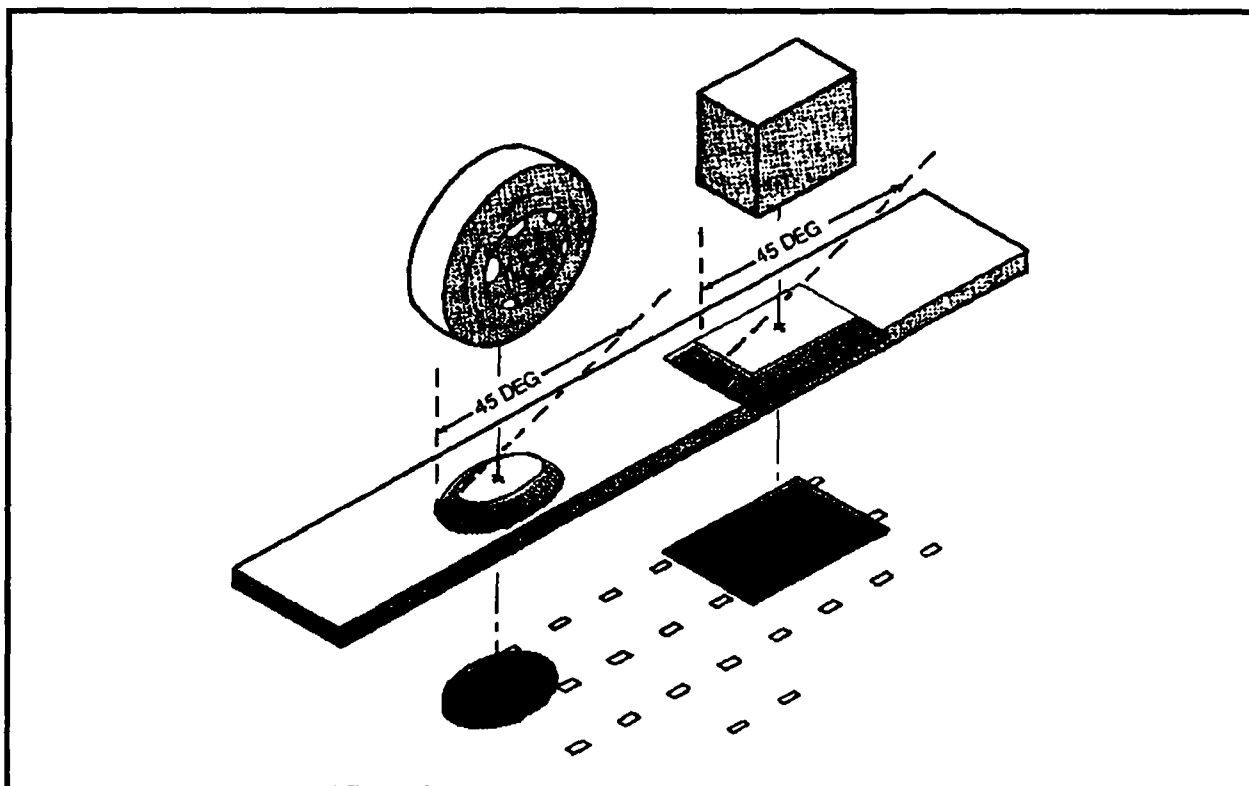


Figure 6-1. Weight Spreading Effect of Shoring.

To determine how much shoring to use for a given load, compare the area of contact between the load and the shoring to the area of contact between the shoring and the aircraft cargo floor. To calculate the contact area of rectangular loads, multiply the width of the item by its length.

Assume that a plank is 2 inches thick. A box resting on it is 12 inches long by 6 inches wide. The area of contact between the box and the plank is 6 times 12 inches, or 72 square inches. Extend imaginary planes down and out from the edges of the bottom of the box through the plank at 45-degree angles. Where these imaginary planes meet the cargo floor, the area of contact will be 10 times 16 inches, or 160 square inches (Figure 6-2).

In this case, the area of contact has increased by 122 percent, or more than doubled. When 2-inch-thick shoring is used, the area over which the load is distributed is enlarged by a 2-inch border all around the area of contact of the load and the shoring. This border is as wide as the shoring is thick. If the shoring is 1 inch thick, the load bearing border added is 1 inch wide; if the shoring is 3 inches thick, the load bearing border added is 3 inches wide, and so on. Generally, using shoring thicker than 4 inches is not practical. The relation between the width of the border and the thickness of the shoring applies to all shoring.

TYPES OF SHORING

There are three main types of shoring which are named for the way they are used to protect the aircraft cargo floor. They are rolling shoring, parking shoring, and sleeper shoring. All other non-specific types of shoring are considered special shoring.

Rolling Shoring

Use rolling shoring to protect airport parking ramps and the loading ramps and cargo floor of the aircraft from damage. This type of shoring is used to protect surfaces from damage when moving a vehicle across it (Figure 6-3).

The majority of vehicles shipped by air, such as those with pneumatic tires, do not exceed weight limitations and do not require rolling shoring. However, vehicles with cleats, studs, or other gripping devices and treads that allow concentrated contact require rolling shoring. Cleated or lugged wheels can easily damage the aircraft floor or soft surfaces such as asphalt because the total weight of the vehicle is transferred to the cleats or lugs. Therefore, the weight is concentrated into a very small area. Vehicles that allow concentrated contact require rolling shoring thick enough to prevent damage. See Chapter 2 for information on combat and construction vehicles.

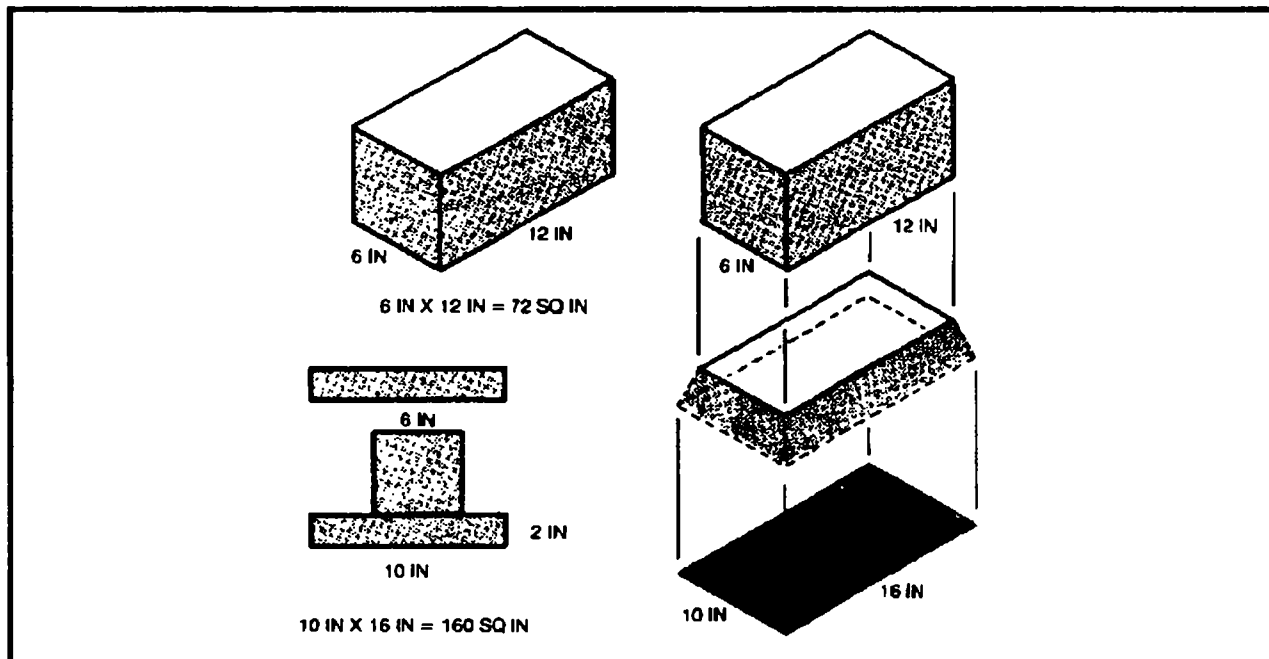


Figure 6-2. Load Spreading Effect of Shoring.

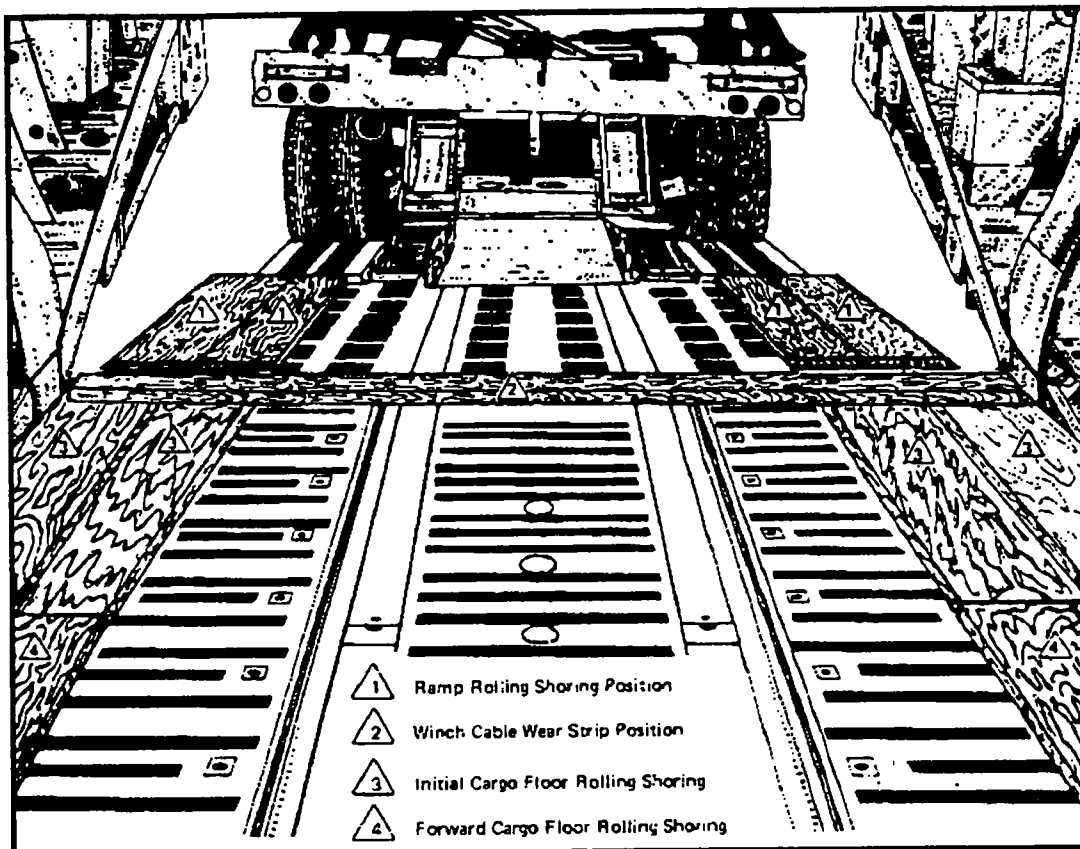


Figure 6-3. Example of Rolling Shoring.

*In all cases, the minimum thickness is 3/4 inch. For cleated vehicles such as bulldozers, shoring shall be thick enough for the cleat or lugs to sink into without contacting the cargo floor. Movement personnel should always plan on rolling and parking shoring for tracked vehicles, even those with new rubber pads. That tracked vehicle may deploy with new track pads, but it will probably not redeploy with new ones. Any vehicle or piece of equipment that requires rolling shoring to load aboard the aircraft will also require parking shoring.

Parking Shoring

Use parking shoring to protect the aircraft floor from damage during flight (Figure 6-4). Any vehicle requiring rolling shoring also requires parking shoring. Each aircraft has specific floor weight limitations that apply to wheeled and non-wheeled items of cargo. If the vehicle exceeds these weight limitations, it must have parking shoring before it may be transported by air. There is no need to learn the mathematical process used to calculate shoring requirements. But some general

considerations regarding parking shoring should be remembered when planning an airlift movement:

- The minimum thickness of parking shoring is 3/4 inch.
- Use parking shoring to protect the aircraft floor or aircraft loading ramps from concentrated contact or metal-to-metal contact, such as steel wheels and trailer tongue supports and wheels.
- Most pneumatic tires do not require parking shoring. Those that do are usually very narrow or heavy (over 5,000 pounds).
- Always use parking shoring when rolling shoring is required.
- Always use parking shoring on 463L pallets when the items have sharp edges or protrusions that could damage the pallet's aluminum surface. Contact the affiliated AMC ALCS for guidance about specific vehicles or aircraft limitations.

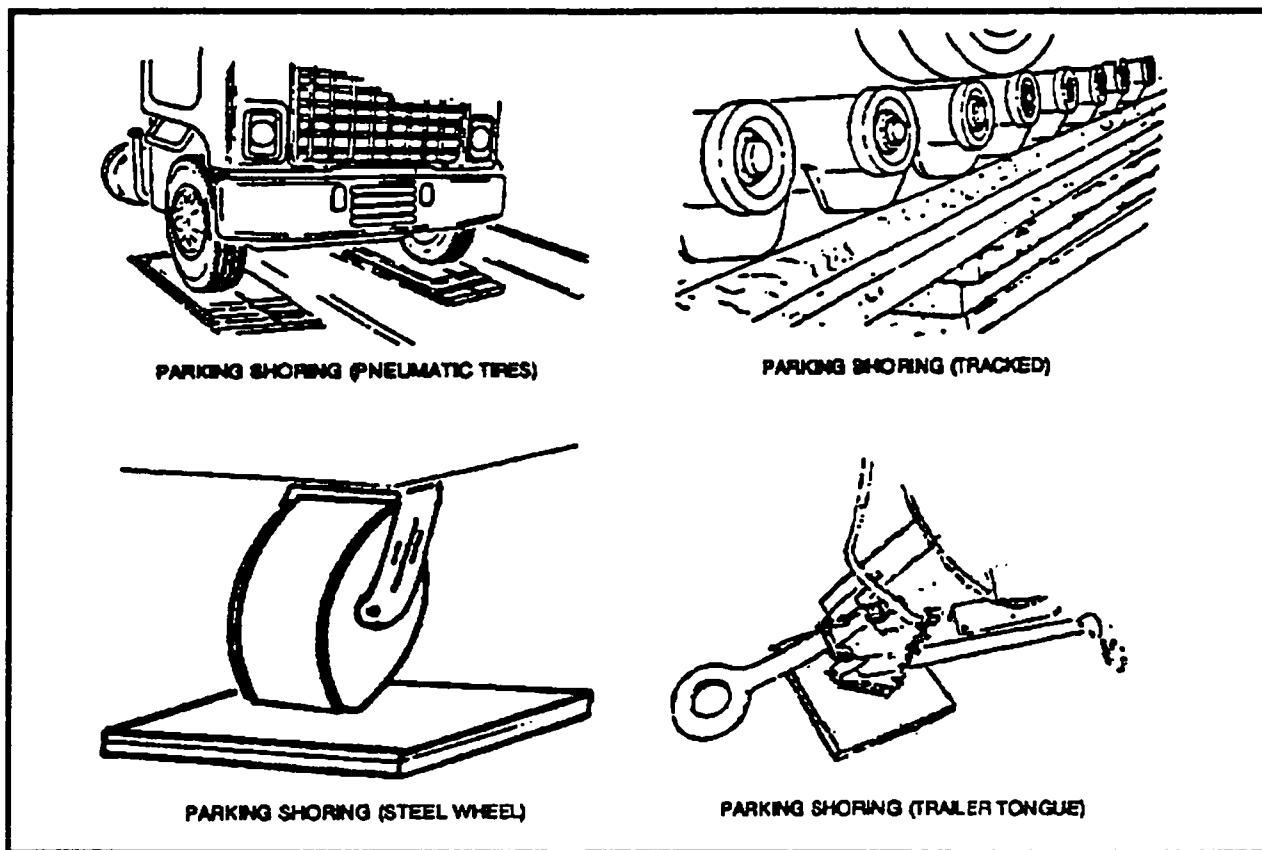


Figure 6-4. Examples of Parking Shoring.

Sleeper Shoring

Use sleeper shoring under the frame or axle of any special-purpose vehicle, such as a forklift, scoop loader, or grader, that weighs over 20,000 pounds and has tires that are not designed for highway travel. Depending on the type of vehicle, sleeper shoring is placed between the aircraft floor and a structured part of the vehicle, such as the frame or axle (Figure 6-5). This type of shoring prevents the vehicle from bouncing up and down and possibly pulling the tie-down rings out of the aircraft floor. An aircraft encountering turbulence during flight may cause these vehicles to oscillate and place extreme forces on the tie-down devices and tie-down points that would exceed their rated capacities.

Special Shoring

Special shoring consists of approach shoring, ramp pedestal shoring, bridge shoring, and other nonspecific types of shoring.

Approach shoring has a specific application. Use approach shoring to decrease the approach angle of the aircraft loading ramps (Figure 6-6) because some items of cargo will strike the aircraft or ground during loading and unloading operations. Although there is no standard method to calculate when and how much approach shoring to use, most helicopters and many long vehicles that have limited ground clearance, such as lowboys, will require varying amounts of approach shoring. Plan to transport any required approach shoring aboard the same aircraft as the item that requires the shoring.

Use ramp pedestal shoring with approach shoring to adjust the height of the ramp to match requirements of the approach shoring.

Use bridge shoring to take advantage of the greater strength of the vehicle treadways of the aircraft cargo floor. It allows heavy cargo to be positioned between the treadways without

overloading the center floor area. Shoring is first placed either lengthwise (nose to tail) or laterally on the treadways (Figure 6-7). The position of the shoring on the treadways depends on the load to be supported and the strength of the aircraft

floor. Planks or beams are positioned on top of the shoring planks and form the bridge. The bridge must be strong enough that any sag under the load is not readily apparent. When beams are used, they should be at least as wide as they are thick.

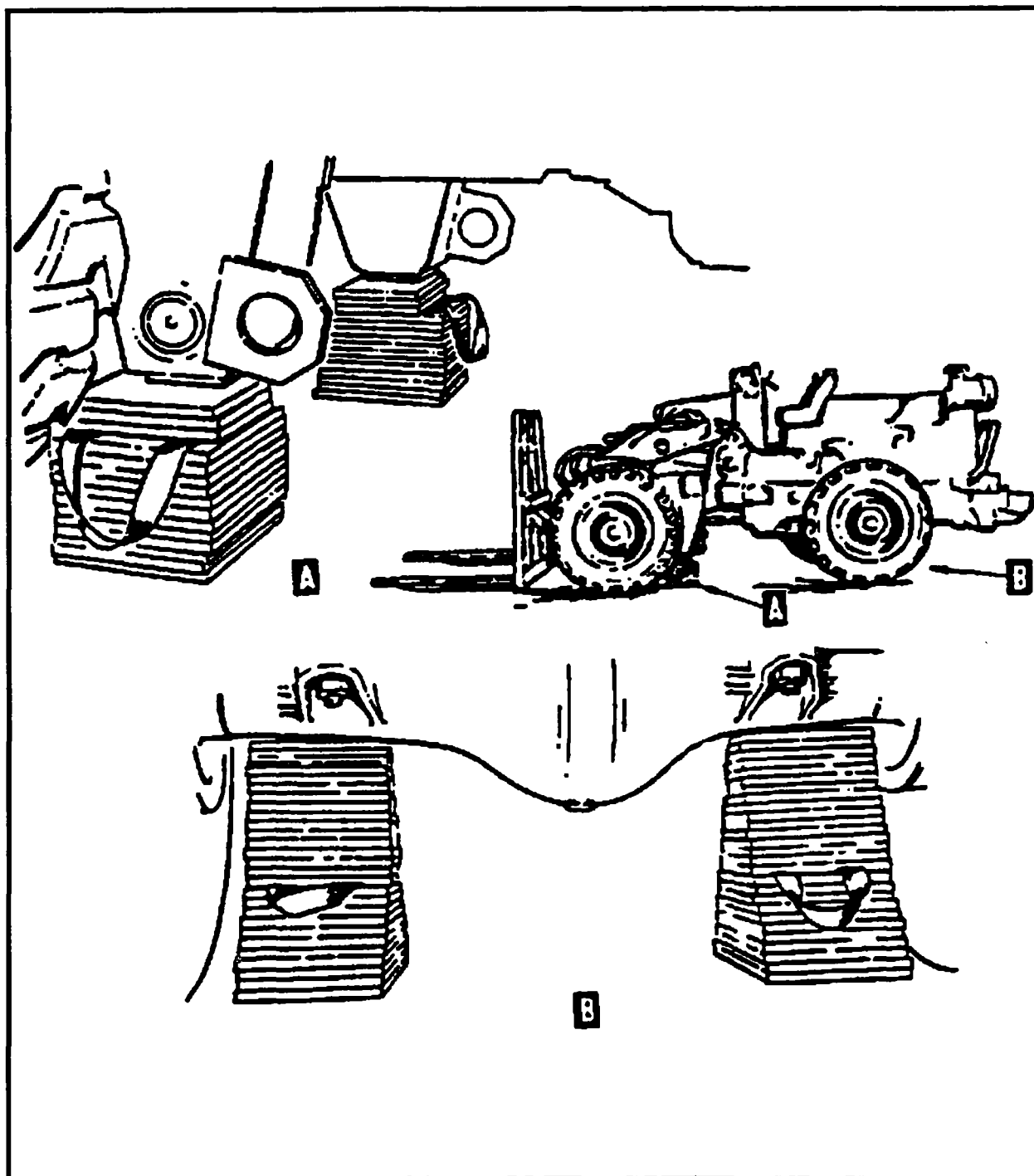


Figure 6-5. Example of Sleeper Shoring.

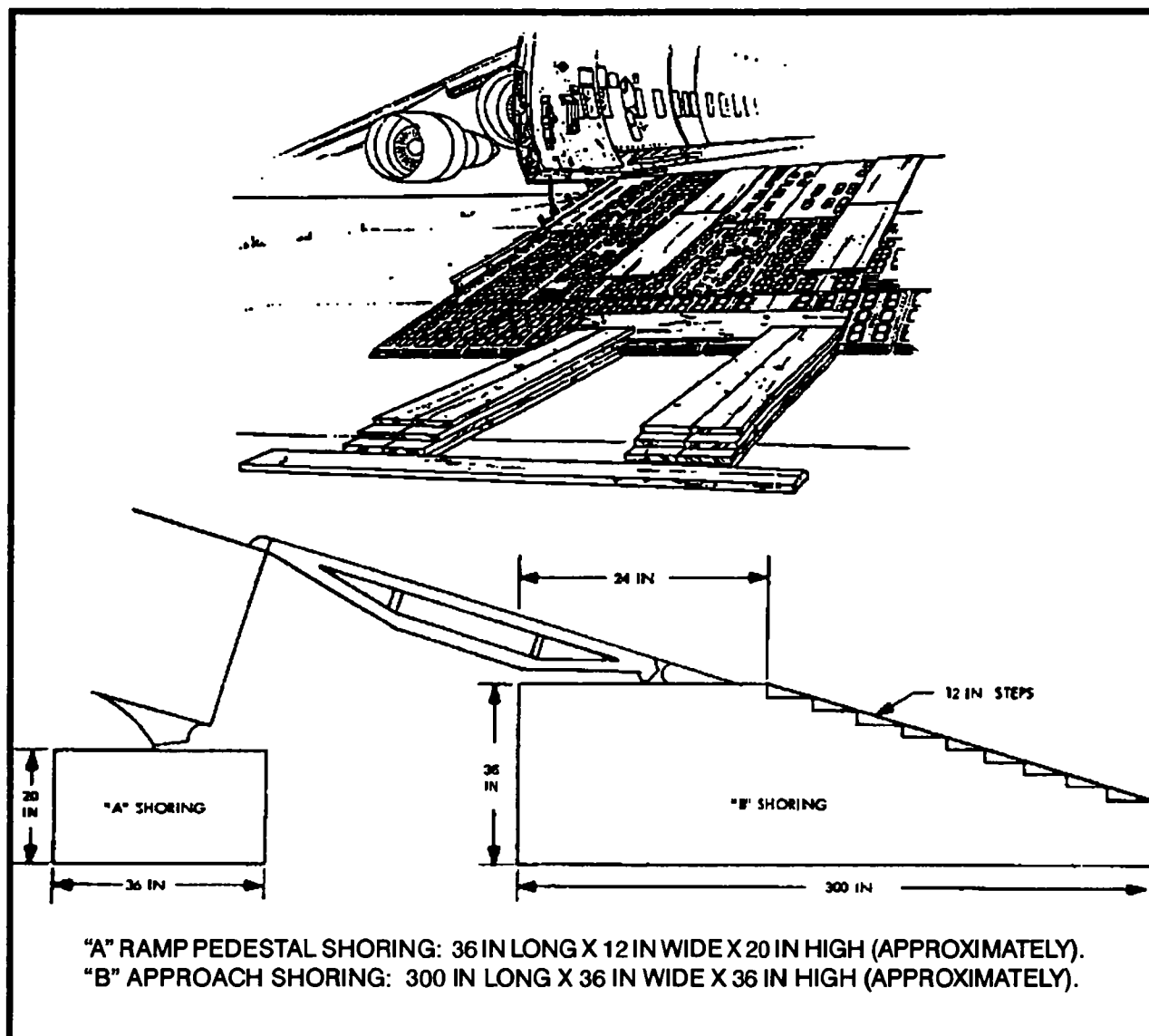


Figure 6-6. Examples of Approach Shoring..

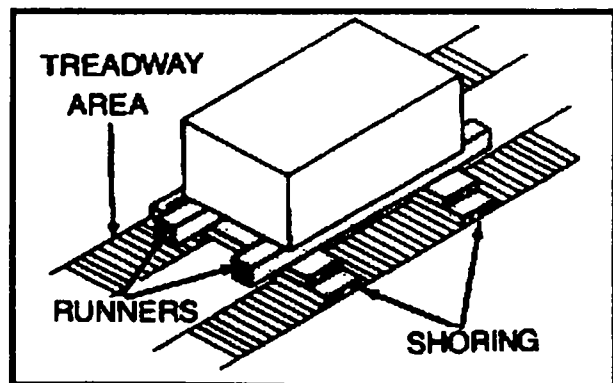


Figure 6-7. Example of Bridge Shoring.

SIZE AND CONDITION OF SHORING

Each planned aircraft load will probably need shoring. The load configuration and weight determine the thickness and width of the shoring to be used. In general, lumber 10 or 12 inches wide and 2 inches thick is most suitable. Lengths of shoring can be cut to meet specific needs. For easier handling, however, the length of shoring should not exceed 12 feet. Plywood also makes good shoring. One 4- by 8-foot sheet of 1-inch plywood can be cut into four 1- by 8-foot or two 2- by 8-foot pieces of shoring. These are ideal for loading tracked vehicles.

All dimensions (thickness, length, and width) for required shoring must be actual size. Commercial-size lumber may not satisfy this requirement. For example, a 1 5/8- by 3 5/8-inch piece of lumber will not satisfy a 2- by 4-inch requirement.

Inspect shoring before use to ensure that it is clean, sound, free of nails, and fit for its intended use. Any defect in the lumber reduces its strength. Split lumber will not transfer the weight of the cargo past the split. The aircraft loadmaster may reject dirty, badly warped lumber, which will delay the loading of the aircraft.

Shoring requirements must be identified and obtained as soon as possible to ensure unit readiness. Units should plan on storing shoring and should be prepared to adjust unit needs as equipment changes.

TRANSPORT OF SHORING

When shoring is required to load cargo, it will also be needed to unload. If shoring is not available at the destination, then the shoring must be transported with the load. Include the weight of the shoring with the weight of the cargo to accurately determine the aircraft center of gravity. For tracked vehicles, simply load the lumber on top of the vehicle while it is being weighed. The weight of the shoring will not affect the vehicle center of balance. For rough terrain forklifts or other pieces of equipment that require sleeper shoring, weigh the shoring separately and add the weight to the vehicle weight. For trailers or other pieces of equipment that only require shoring under the tongue, do not worry about the weight, but always make sure adequate shoring is available.

A 3/4-inch thick by 4-foot wide by 8-foot long plywood panel weighs about 65 pounds. A 2-inch thick by 12-inch wide by 12-foot long plank weighs about 75 pounds.

SHORING REQUIREMENTS

*To find out how much shoring to use, find out how many pounds per square inch of pressure the cargo will put on the aircraft floor. The C-130 and C-141 aircraft have a pound-per-square-inch limitation, so the purpose of the calculations is to find the minimum amount of shoring necessary to do the job. Too much shoring may make the cargo too heavy to fly; too little shoring may allow the weight of the cargo to damage the aircraft.

To find the pressure rating of a piece of cargo, use two formulas: one to find how many square inches of the cargo will actually contact the cargo floor (area) and the second to find the actual pressure or weight of the piece of cargo.

For example, you have a trailer tongue support leg with a contact length of 3 inches and a contact width of 2 inches. The trailer tongue support leg will rest on the aircraft floor. The support leg weighs 325 pounds. Multiply the length by the width to get the area, in this case, 6 square inches.

$$L \times W = A \quad 3 \times 2 = 6 \text{ square inches}$$

To find the psi of that trailer support leg, divide the support leg weight by the area. For this example, it is 54.2 psi.

$$\frac{W}{A} = \text{PSI} \quad \frac{325}{6} = 54.2 \text{ psi}$$

If the aircraft floor limit is 25 pounds per square inch, then place shoring under the support leg to spread the load. A 1/2-inch-thick piece of shoring will not be enough, so put a 3/4-inch-thick board under the support leg.

Shoring is not effective under its entire length, but only at a 45-degree angle from the edge of the piece of cargo. So 3/4-inch-thick shoring will spread the load only 3/4 inch on each side of the cargo. This results in spreading the load over an area of 4.5 by 3.5 inches.

$$4.5 \times 3.5 = 15.75 \text{ square inches}$$

This reduces the psi to 20.7. Therefore, a 3/4-inch-thick board measuring 4.5 by 3.5 inches under the trailer support leg safely places it on the aircraft floor.

$$\frac{325}{15.75} = 20.63 \text{ or } 20.7 \text{ psi}$$

NOTE: When rounding figures, always round pressure figures up to the next higher tenth of an inch. For example, 2.69 psi would round up to 2.7 psi. Always round area figures down to the next lower tenth (7.58 will be 7.5 square inches). This provides an increased safety factor. The psi is higher than it actually is, and the area is smaller than it actually is.

FORMULAS

The basic formulas for computing area and pounds of pressure for various shaped objects are in Figure 6-8.

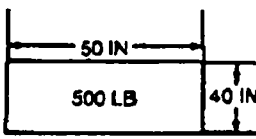
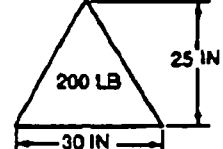
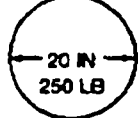
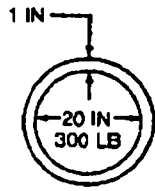
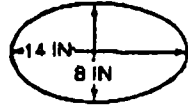
RECTANGLE Weight divided by length times width. $\frac{\text{Weight}}{\text{Length} \times \text{Width}} = \text{Pressure} \quad \frac{500}{50 \times 40} = 0.25 \text{ lb/in}^2$	
TRIANGLE Weight divided by one half the base of triangle times the height. $\frac{\text{Weight}}{\frac{1}{2} \text{ Base} \times \text{Height}} = \text{Pressure} \quad \frac{200}{15 \times 25} = 0.53 \text{ or } 0.6 \text{ lb/in}^2$	
CIRCLE Weight divided by diameter squared times 0.785. $\frac{\text{Weight}}{\text{Diameter}^2 \times 0.785} = \text{Pressure} \quad \frac{250}{20^2 \times 0.785} = 0.79 \text{ or } 0.8 \text{ lb/in}^2$	
CIRCULAR BARREL WITH RIM Weight divided by outside diameter squared minus inside diameter squared times 0.785. $\frac{\text{Weight}}{\text{Outside Diameter}^2 - \text{Inside Diameter}^2 \times 0.785} = \text{Pressure}$ $\frac{300}{22^2 - 20^2 \times 0.785} = 4.54 \text{ or } 4.6 \text{ lb/in}^2$	
TIRE PAD Weight of axle divided by length times width of tire pad times 0.785 times number of tires on the axle. (Each axle of a vehicle must be computed separately.) $\frac{\text{Weight of Axle}}{\text{Length} \times \text{Width} \times 0.785 \times \text{No. Tires on Axle}} = \text{lb/in}^2$ $\frac{1,100}{14 \times 8 \times 0.785 \times 2} = 6.25 \text{ or } 6.3 \text{ lb/in}^2$	 TWO-WHEELED AXLE WEIGHT 1,100 LB

Figure 6-8. Formulas.

CHAPTER 7

CARGO RESTRAINT

INTRODUCTION

This chapter provides guidelines for restraining cargo on military and civilian aircraft. Cargo is restrained (tied down) in an aircraft so that it remains stationary in the cargo compartment when the aircraft is subjected to rough air, vibration, acceleration, deceleration, and rough landings. The greatest force exerted on the cargo is usually the forward movement encountered when the aircraft slows rapidly on landing. When the pilot applies the aircraft brakes on landing, the cargo tends to keep moving at a higher speed. The cargo is also restrained in proportion to its weight, so that it will not shift when the aircraft turns, takes off, lands, or encounters other forces while flying. Tie-down equipment is aboard the aircraft to be used as restraints.

PRINCIPLES OF CARGO RESTRAINT

Cargo loaded in an aircraft is restrained so that it will not shift during any condition the aircraft experiences in flight. Basic principles of restraint apply to tying down cargo. Although the details vary for different kinds of cargo, the basic principles of restraint do not change. The basic principles follow:

- Tie down cargo to prevent movement in all directions.
- Install tie-down devices to provide adequate restraint without overstressing the tie-down fitting or damaging the cargo.
- Ensure the tie-down leads directly from the tie-down fitting on the aircraft floor to the load being restrained.
- Attach tie-down devices in symmetrical pairs. Unsymmetrical tie-downs cause uneven load distribution and could result in tie-down failure (Figure 7-1).
- Ensure tie-down pairs in a given direction are equal in type and length. (Any material subjected to a tension load stretches to a given percentage of its length. Therefore,

the greater the length, the greater the potential amount of stretch. If two tie-downs of the same type and capacity restrain a load in a given direction and one tie is longer than the other, the longer tie has a greater stretch potential. The shorter tie assumes the majority of any load that may develop. If as a result the shorter tie is overstressed and fails, the longer tie would be subjected to the full load and it too would probably fail.)

- Use the nylon CGU-1/B strap on cargo that may be damaged by chains, such as fragile/crushable cargo or baggage.

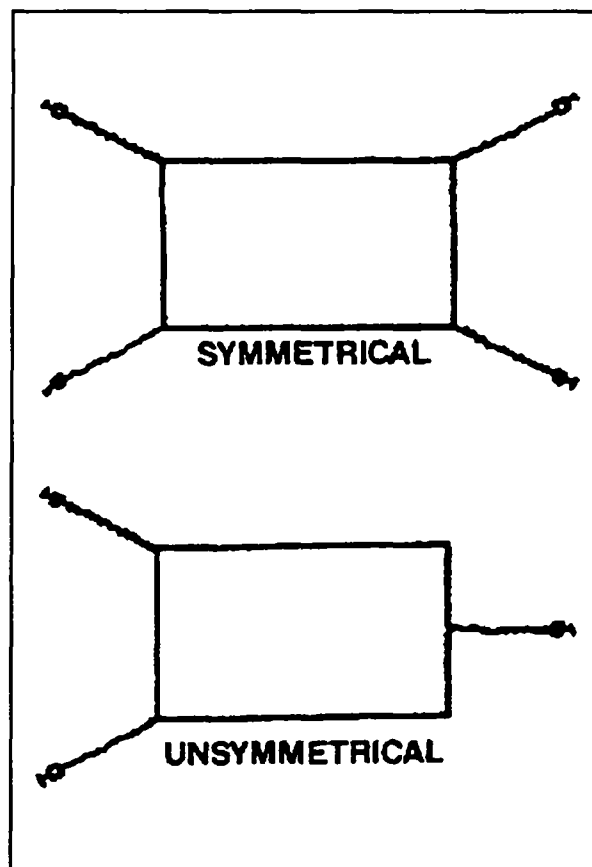


Figure 7-1. Symmetrical and Unsymmetrical Pairing.

RESTRAINT CRITERIA

Restraint criteria for aircraft cargo are based on the weight of the cargo and the forces imposed on it due to changes in motion (changing direction, slowing down, or speeding up). The force increases as the rate of change in motion increases.

*The primary restraint criterion is the minimum amount of restraint needed to keep cargo from moving in a specific direction. A numerical factor (g factor) called restraint safety factor or load factor has been determined for cargo aircraft. This figure determines the number of tie-down devices to use.

*Imagine a passenger traveling in a car at 50 mph. The driver jams on the brakes for a sudden stop. What happens to the passenger when the brakes are applied? The same thing happens to the cargo in an aircraft. A sudden change in direction or speed of the aircraft moves the cargo in the same manner. The change in motion is called the outside force. The amount of outside force to which a unit of cargo may be subjected is called the load or g factor. Multiplying the weight of a unit of cargo by the g factor results in the amount of required restraint for that unit of cargo:

***Weight x G Factor = Required Restraint**

*For example, a unit of cargo weighing 5,000 pounds is to be restrained from moving forward. The forward g factor for the aircraft is 3. Use the formula to determine the total load to be restrained: cargo weight (5,000 pounds) times g factor (3) equals the weight to be restrained against forward movement (15,000 pounds).

DIRECTION OF RESTRAINT

The direction in which the cargo would move if it were not restrained identifies the restraint criteria applied to the cargo to prevent its movement. Forward restraint keeps cargo from moving forward in the aircraft; aft restraint, from moving backward; lateral restraint, from moving to either side; and vertical restraint, from moving up off the aircraft floor. The aircraft floor is downward restraint. Use the restraint criteria in Table 7-1.

Table 7-1. Restraint Criteria.

DIRECTION OF RESTRAINT	*G FACTOR	
	C-130, C-141, C-5, C-17	KC-10
Forward	3.0 g's	1.5 g's ¹ 9.0 g's ²
Aft	1.5 g's	1.5 g's
Lateral (left and right)	1.5 g's	1.5 g's
Vertical	2.0 g's	2.0 g's

¹With the KC-10 cargo barrier net installed.
²Without the KC-10 cargo barrier net.

TIE-DOWN DEVICES

Three tie-down devices are used to secure cargo in the aircraft:

- The MB-1 tie-down device has a 10,000-pound rated capacity.
- The MB-2 tie-down device has a 25,000-pound rated capacity.
- The CGU-1/B tie-down device has a 5,000-pound rated capacity. This device is commonly called a 5,000-pound strap.

The MB-1 and MB-2 devices (Figure 7-2) are similar in looks, use, and the way they operate. The only significant difference is their load capacities and size.

The CGU-1/B tie-down device (Figure 7-3) is a 20-foot nylon web strap with two metal hooks attached. One hook is stationary at one end of the strap, while the other hook has a ratchet device and can be moved over the length of the strap. The ratchet tightens the device when it is being used.

Similar methods are used to restrain all types of cargo. The details for restraining each cargo item vary with its bulk, weight, configuration, and location in the aircraft and whether it is equipped with tie-down provisions. These variations make restraining each piece of cargo a separate problem.

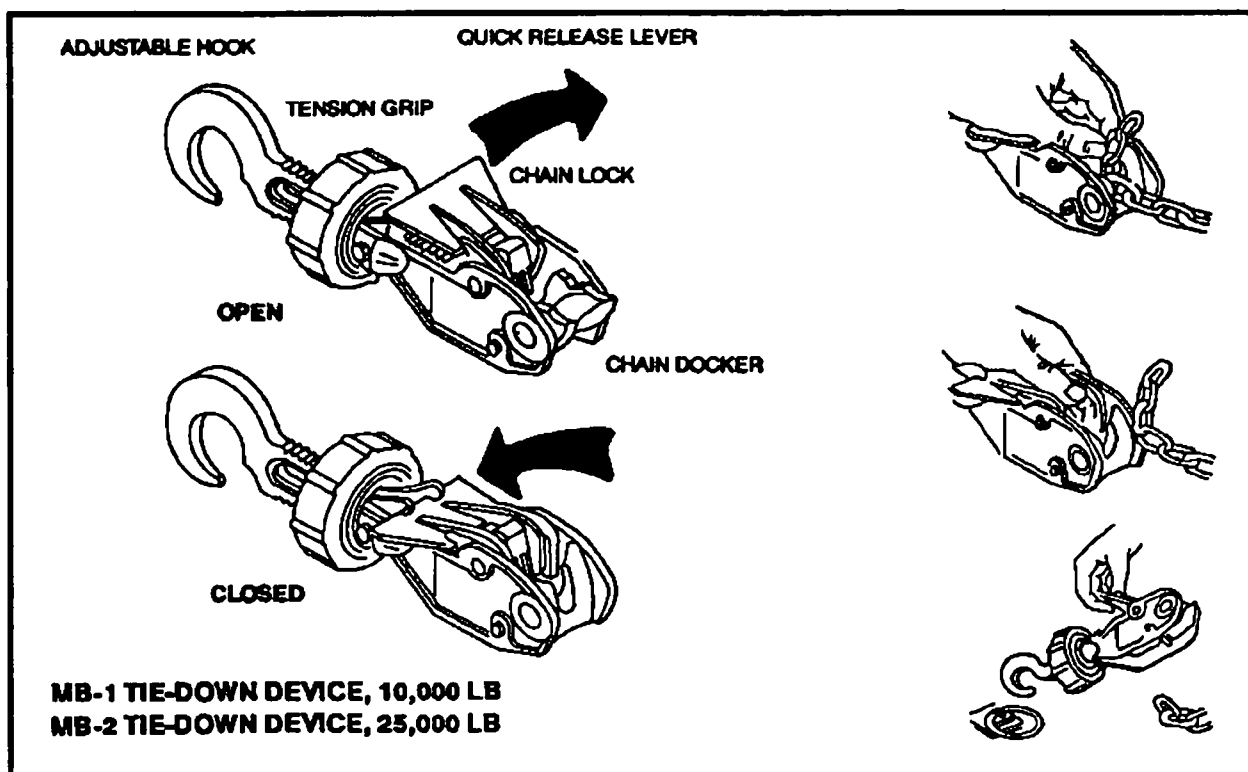


Figure 7-2. MB-1 and MB-2 Tie-Down Devices.

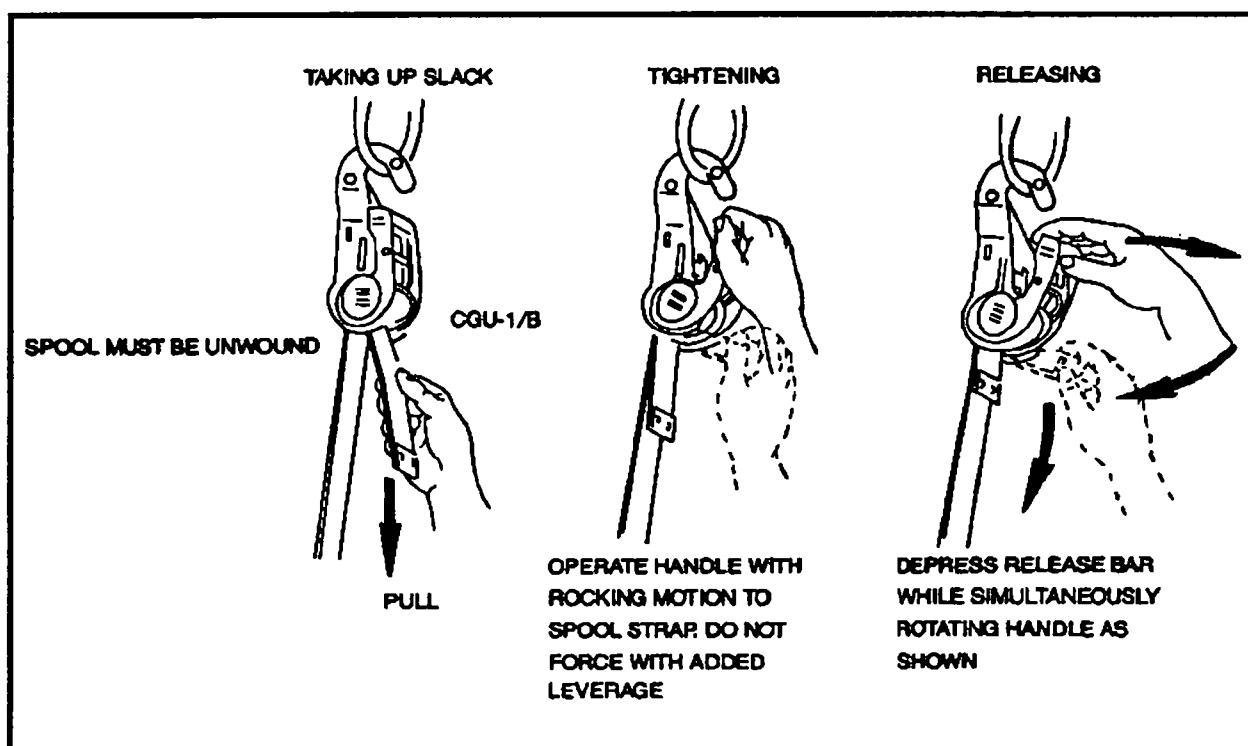


Figure 7-3. CGU-1/B Tie-Down Device.

Turbulence and other violent motions expose airlifted vehicles to extreme gravitational forces that may compress pneumatic tires and thus ease the tension on tie-down chains. When the motion suddenly stops and the aircraft quickly climbs, the chain snaps taut and imposes abnormal loads on aircraft and cargo tie-down fittings and tie-down devices. This same reaction may occur when the vehicle's springs flex under the same conditions. Special-purpose vehicles equipped with large soft tires, such as rough terrain forklifts, can encounter these stress conditions in the aircraft.

Some vehicles are made so that each major component part must be tied down. An example is the truck-mounted crane. The crane is mounted on the truck chassis by a large-diameter kingpin. Because vertical acceleration might disengage the kingpin, both the truck chassis and the crane must be tied down.

The basic rules for applying tie-down devices follow:

- Use standard tie-down devices that are provided aboard the aircraft.
- Know the capabilities of each tie-down device used.
- Use an even number of chains symmetrically in pairs.
- Know the restraint criteria in each direction (forward, aft, lateral, and vertical), then compute the restraint required.
- Maintain equal tensions throughout the tie-down arrangement when attaching the tie-down devices to cargo and tie-down fittings.
- Install tie-down devices at a 30-degree angle from the cargo compartment floor and 30 degrees from the longitudinal axis whenever possible.
- Ensure the right capacity tie-down device is used with the tie-down fitting. All aircraft floor tie-down fittings are not the same capacity. Avoid placing a 25,000-pound-capacity tie-down device on a 10,000-pound-capacity tie-down fitting. Otherwise, it provides only 10,000 pounds of restraint.
- Turn the rings in the floor tie-down fittings so that the tension is applied to the top of the ring, not the sides.
- Consider the capacity of the tie-down device and the strength of the attaching points when attaching chains to vehicles. Attach tie-down devices to lifting shackles or other points that were designed for this purpose first. If additional restraint is required, attach devices to available strong structural points, such as tow hooks, bumper supports, axles, or frame members. (Do not place chains against brake lines, hydraulic lines, fuel lines, tires, or electrical wiring.) Do not attach tie-downs to steering mechanisms, tie rods, driveshafts, grills, or fender and body braces (Figure 7-4).
- Do not attach more than 50 percent of required tie-down devices in a given direction to vehicle axles.
- When chains cross over one another, make sure that they pull in a straight line and not against one another.
- When forming chain loops around axles and bumpers, do not depend on friction or tension to prevent the chain from sliding laterally. Place the chain loop against some solid part, such as a differential housing or bumper bracket.
- When using CGU-1B tie-down devices to tie down cargo, do not use nylon devices over sharp edges.
- Attach the tie-down devices to the aircraft floor and the chain to the cargo item.

TIE-DOWN DEVICE STRENGTH

Every tie-down device is rated to withstand a given force. The tie-down devices restrain up to their rated capacity only when applied so that the force exerted is parallel to or straight onto the device. When the tie-down device is applied like this, all of its rated capacity is available to prevent the cargo from moving in the direction of the plane angle.

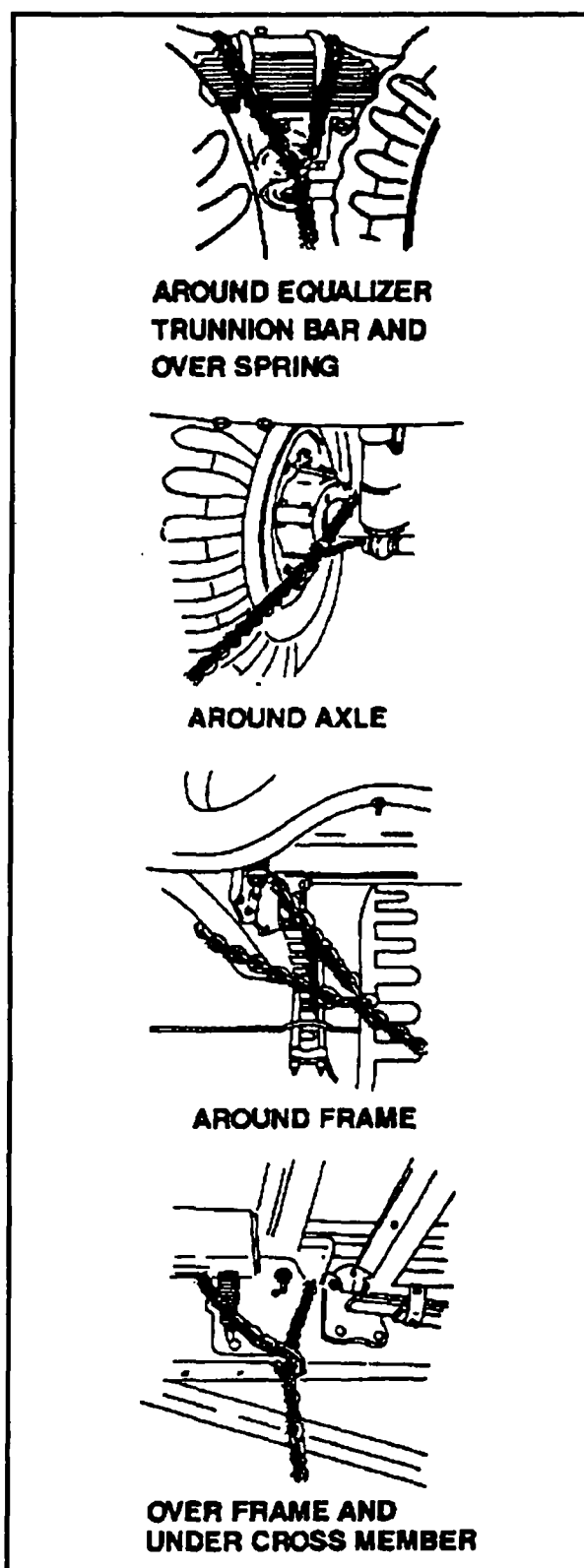


Figure 7-4. Vehicle Tie-Downs.

To determine the number of tie-down devices required to properly secure any given item of cargo, know how each of the following influences cargo tie-down:

- Weight of cargo.
- Restraint factor for each direction (g force).
- Floor and plane angles of devices when attached.
- Rated strength of tie-down devices to be used.
- Strength of tie-down fittings on aircraft floor and cargo item.

*To find the force that must be restrained, use the first two factors: weight of the cargo and the restraint factor. Written in formula form, it is--

$$G \times W = F$$

Where:

Restraint factor = G

Weight of the cargo = W

Force to be restrained = F

REQUIRED NUMBER OF TIE-DOWN DEVICES

The two methods for determining the number of tie-down devices needed to secure a load in an aircraft are the percentage restraint chart and the percent of angle of tie. The percentage restraint chart is a quick method for advance estimating of the number of tie-down devices required. This method is not as precise as the percent of angle of tie. The percent of angle of tie is the most precise method to find the exact restraint achieved. It uses several formulas that require knowing the exact angle of tie and cannot be used for advance planning.

Percentage Restraint Chart

The percent of angle of tie can be determined by using the percentage restraint chart (Figure 7-5). Floor angle degrees are in the top horizontal row, and plane angle degrees are in the left vertical row. To find the percent of effectiveness of a 30/30-degree angle, first read the floor angle across the top of the chart (30 degrees). The figure directly below the floor angle degree is the percentage of

rated strength for vertical (up) restraint. Next, read the plane angle down the left side of the chart (30 degrees). Next to the plane angle are LON (longitudinal) and LAT (lateral), the directions in which the tie-down will be effective. Read across the table until the 30-degree plane angle line intersects the 30-degree floor angle column.

The numbers at this intersection represent the restraint provided by a restraint device applied at a 30/30-degree angle. These numbers express a percentage of the maximum rated strength of a tie-down device. A device rated at 10,000 pounds would provide 7,490 pounds of longitudinal

restraint, 4,330 pounds of lateral restraint, and 5,000 pounds of vertical restraint.

The formulas will help determine how many of each type of tie-down device should be used for each piece of cargo. Do not mix the types of devices. If the formulas say to use MB-2 devices, do not substitute a lower-rated device or the restraint will be insufficient.

Remember also to use the devices in pairs. If the answer is not an exact even number, always round up to the next highest even number when using chains. For example, if the figures came out to 2.2 devices, apply 4.

NOTE: Angles across the top are those formed between the tie-down device and the cabin floor.
2. Angles down the side are those formed between the tie-down device and the longitudinal axis of the aircraft.
* Vertical restraint is related only to the angle between the tie-down device and the cabin floor. The lateral angle has no bearing on it.
** The "best compromise" position

FLOOR ANGLE - DEGREES

		5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	
PLAN ANGLE - DEGREES	VERTICAL *	8.7	17.4	25.9	34.2	42.3	50.0	57.4	64.3	70.7	76.6	81.9	86.6	90.6	93.9	96.6	98.5	99.6	
	5°	LON	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3	8.7
	LAT	9.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5	0.8	
	10°	LON	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1	8.6
	LAT	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0	1.5	
	15°	LON	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8	8.4
	LAT	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5	2.3	
	20°	LON	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6	8.2
	LAT	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	18.6	17.1	14.5	11.7	8.8	5.9	2.9	
	25°	LON	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9
	LAT	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7	
	30°	LON	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.8	29.6	22.4	15.1	7.5
	LAT	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4	
	35°	LON	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1
	LAT	57.2	56.5	55.4	53.8	52.0	49.7	47.0	43.9	40.6	36.9	32.8	28.7	24.3	19.6	14.9	9.9	4.9	
	40°	LON	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.8	38.3	32.4	26.2	19.8	13.3	6.7
	LAT	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.8	
	45°	LON	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
LAT	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2		
50°	LON	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.8	
LAT	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.8	38.3	32.4	26.2	19.8	13.3	6.7		
55°	LON	57.2	56.5	55.4	53.8	52.0	49.7	47.0	43.9	40.6	36.9	32.8	28.7	24.3	19.6	14.9	9.9	4.9	
LAT	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1		
60°	LON	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4	
LAT	85.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.8	29.6	22.4	15.1	7.5		
65°	LON	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7	
LON	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9		
70°	LON	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9	2.9	
LAT	93.6	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6	8.2	
LON	2																		

Figure 7-5. Percentage Restraint Chart.

*If a cargo item weighs 8,000 pounds, its restraint must withstand a 3 G. forward force using MB-1 tie-down devices attached on 30-degree floor and plane angles. Attached at these angles, the effective holding strength of the MB-1 is 74.9 percent of its rated strength of 10,000 pounds.

The formula for determining the required number of devices is--

$$\frac{\text{Restraint Factor} \times \text{Weight of Cargo}}{\text{Strength of Device} \times \text{Percent of Angle of Tie-Down}}$$

$$= \frac{\text{Force to be Restrained}}{\text{Effective Holding Strength of Device}}$$

$$= \text{Total Number of Devices Required, or}$$

$$\frac{G \times W}{R \times P} = \frac{F}{S} = N$$

Substituting numbers, the calculation is--

$$\frac{3G \times 8,000 \text{ pounds}}{10,000 \text{ pounds} \times 75 \text{ percent}} = \frac{24,000}{7,500}$$

$$= 3.2 \text{ or } 4 \text{ devices needed}$$

Multiplying the rated strength of the device by the percent of angles at which it is attached equals the effective holding strength of the tie-down device. Written as a formula, it is--

$$R \times P = S$$

Where:

Rated strength = R

Percent of angle of tie-down = P

Effective strength of each device = S

Combine the results of the first two formulas to find how many devices to use for each piece of cargo:

$$\frac{F}{S} = N$$

Where:

Force to be restrained = F

Effective strength of each device = S

Number of devices required = N

The product of this formula gives only the number of devices required for one direction of

restraint. Use the same process for aft, lateral, and vertical restraint as well. Displaying all the calculations in table form makes the total amount of calculation easier (Figure 7-6). The example in Figure 7-6 represents a 45/45-degree angle.

To use the chart, follow the order of calculations as they are listed along the top. Blocks 1 and 2 (Direction of Restraint and Restraint Factor) always contain the information shown in Figure 7-6. The restraint factors for Air Force aircraft have been determined through scientific analysis and cannot be changed by the unit. The unit must supply the information in the rest of the blocks.

Block 3: Cargo weight is the total weight of the vehicle or cargo. It includes any cargo in the vehicles, vehicle fuel, shoring, and any other additions. It does not include the weight of the driver or crew of any vehicle.

Block 4: Force to be restrained is the answer when Block 2 is multiplied by Block 3.

Block 5: Effective strength of device is found using the restraint percentage chart (Figure 7-5). Determine the angle of tie to be used, read right for plane angle and down for floor angle, and find the percent of effectiveness for the device at this angle. Multiply the percent of effectiveness by the rated strength to get the effective strength of the device. Enter the result in Block 5.

Block 6: Devices needed is the answer when Block 4 is divided by Block 5. If the answer is a fraction, always round up to the next highest even number. (This number is always even because the tie-down devices are used in pairs.)

Block 7: Restraint achieved is the answer when Block 5 is multiplied by Block 6. This is a cross-check to ensure that enough restraint is being used. If the figure in Block 7 is lower than that in Block 4, more devices must be added.

NOTE: The devices used versus the devices needed could be different from the figure in Block 6. When tie-down devices are applied at an angle, they will provide restraint in more than one direction. The same chains used for fore and aft restraint will also provide vertical and lateral restraint. Only if the fore and aft restraint is insufficient for vertical and lateral restraint will more devices have to be added.

Percent of Angle of Tie

It is not always possible to apply tie-down devices at a known or desired angle because of cargo configuration or interference by other cargo. After tie-down devices have been applied to a cargo item, their effective restraining strength is found by measuring the lengths of the chains. The percent of angle of tie is used to determine if enough restraint has been applied to a piece of cargo after it is loaded and restrained in the aircraft.

Tie-downs attached to a load usually provide restraint in three measurable directions: on a vertical plane, a lateral plane, and a longitudinal plane. The vertical angle is the angle between the chain from the attachment point or tie-down fitting (Figure 7-7, A and B) and the aircraft floor. The lateral plane angle (Figure 7-7, A and C) is the angle between the chain and a line which runs across the cargo compartment through the attachment point. The longitudinal plane angle (Figure 7-7, A and D) is the angle between the

chain and a line which runs fore and aft in the cargo compartment through the attachment point.

NOTE: For ease of illustration, Figure 7-7 shows only one tie-down device. However, tie-down devices must be attached in pairs, with each device having the same angles. Attaching a pair of tie-down devices to the opposite ends of the cargo item will provide restraint against movement in all directions.

When a tie-down device is attached at an angle, its effectiveness is reduced; the greater the angle, the greater the reduction.

EXAMPLE 1:

Use a 25,000-pound-capacity MB-2 tie-down device applied to a cargo item. Figure 7-7 shows a method to determine effective restraint for cargo tie-down. As shown, determine tie-down ratios by dividing tie-down chain length into the effective length for the direction in which restraint is required. Then multiply this ratio by the strength of the tie-down chain or attachment point, whichever is less, to find the restraint received from the tie-down pattern used.

1. Measure the length of the tie-down chain (A) from the tie-down fitting to the attachment point on the cargo: 50 inches.
2. Measure the effective vertical length (B) from the attachment point on the cargo to a point directly beneath it on the cargo floor: 25 inches.

<u>1</u> Direction of Restraint	<u>2</u> Restraint Factor	<u>3</u> Cargo Weight	<u>4</u> Force to be Restrained	<u>5</u> Effective Strength of Device	<u>6</u> Devices Needed	<u>7</u> Restraint Achieved
Fwd	3.0	8,000	24,000	7,490	4	29,960
Aft	1.5	8,000	12,000	7,490	2	14,980
Lat	1.5	8,000	12,000	4,330	4	17,320
Vert	2.0	8,000	16,000	5,000	4	20,000

Figure 7-6. Restraint Calculations Chart.

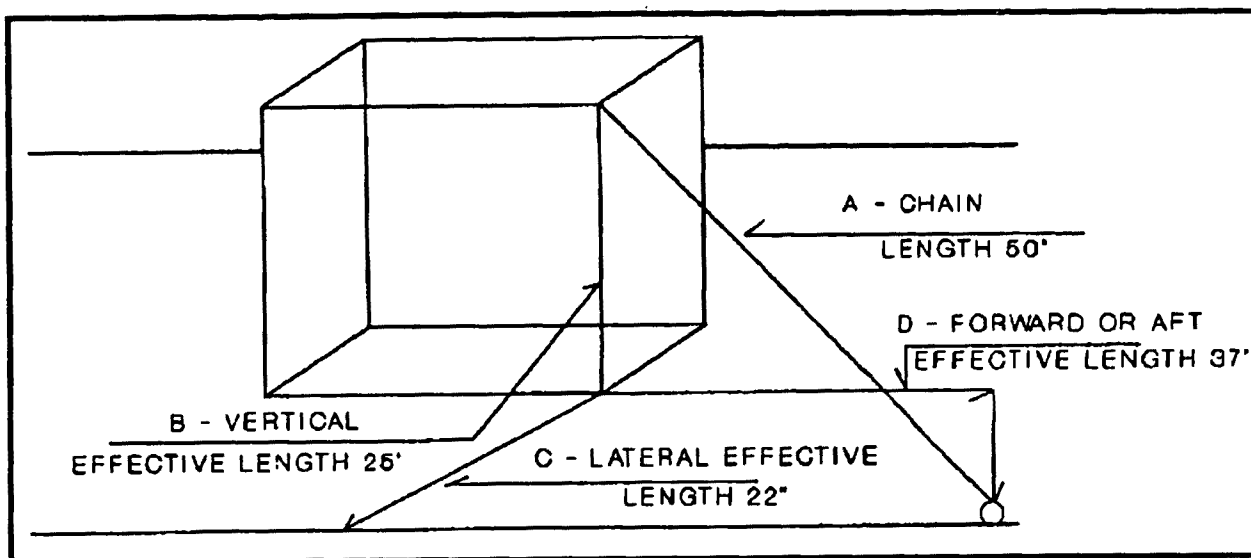


Figure 7-7. Tie-Down Angle Computations.

3. Divide the tie-down chain length (A) into the vertical effective length (B) to determine the ratio:

$$\frac{25}{50} = 0.50 \text{ ratio}$$

4. Multiply this ratio by the rated restraint (25,000 pounds) of the tie-down chain:

$$25,000 \times 0.50 = 12,500 \text{ pounds of effective vertical restraint received from the chain}$$

5. To determine the effective forward or aft restraint, obtain a forward or aft effective length (C) by measuring from a point directly beneath the attachment point on the cargo along a longitudinal axis to a point lateral to the tie-down fitting being used: 37 inches.

6. Divide the tie-down chain length (A) into the forward or aft effective length (D) to determine the ratio:

$$\frac{37}{50} = 0.74 \text{ ratio}$$

7. Multiply this ratio by the rated restraint (25,000 pounds) of the tie-down chain:

$$25,000 \times 0.74 = 18,500 \text{ pounds of effective forward or aft restraint received from chain}$$

8. To determine the effective lateral restraint, obtain a lateral effective length (E) by measuring from a point directly beneath the attachment point on the cargo to the row of tie-down fittings being used: 22 inches.

9. Divide the tie-down chain length (1) into the lateral effective length (8) to determine the ratio:

$$\frac{22}{50} = 0.44 \text{ ratio}$$

10. Multiply this ratio by the rated restraint (25,000 pounds) of the tie-down chain:

$$25,000 \times 0.44 = 11,000 \text{ pounds of effective lateral restraint received from the chain}$$

EXAMPLE 2:

If the tie-down device in Figure 7-7 were an MB-1 rated at a maximum capacity of 10,000 pounds, it would provide 50 percent or 5,000 pounds of its vertical, 74 percent or 7,400 pounds of its longitudinal, and 44 percent or 4,400 pounds of its lateral restraint capacity.

NOTE: If the tie-down chain is attached to a pallet ring, the rated restraint would be 7,500 pounds. The ratio would be multiplied by 7,500 to determine the effective restraint received.

PALLETS

The Air Force 463L cargo-handling system is designed to increase loading and unloading efficiency and to reduce operating costs. Small items of cargo are difficult to properly restrain. Cardboard CONEX inserts or standard wood pallets may be used to consolidate small items into a larger unit. CONEX inserts and wood pallets with cargo will then be placed on Air Force 463L cargo pallets and secured with Air Force cargo restraining nets.

The three nets of the 463L pallet will restrain up to 10,000 pounds of general cargo on any single

pallet without having to use any other tie-down devices. The 463L pallet may be used as a mobility platform for other than general cargo weighing more than 10,000 pounds. Palletized loads over 10,000 pounds cannot be restrained with nets and must be secured with chains and devices to the aircraft floor, the pallet rings, or restraint rail tie-down rings.

NOTE: The Air Force loadmaster (or boom operator on the KC-10) has final authority in determining adequate cargo restraint.

APPENDIX A

COMMON AIR MOBILITY COMMAND AIRCRAFT CONFIGURATIONS

INTRODUCTION

This appendix provides a reference for airlift aircraft standard configurations to meet the mission requirement of the airlifted force and the Air Mobility Command. Only those configurations that are common to your airlift movement are described. All information was extracted from the following AMC regulations:

<u>AIRCRAFT</u>	<u>EXTRACT FROM</u>
C-5 Configurations	AMCR 55-26
KC-10 Configurations	T.O. 1C-10(K)A-9
C-130 Configurations	AMCR 55-47
C-141 Configurations	AMCR 55-4

Information in this appendix is for reference only. If a specific question arises regarding any configuration requirement capability, contact your affiliated ALCS for further guidance.

C-5 CONFIGURATIONS

Because of the unique design of the C-5 aircraft, there are only three configurations to be concerned with. The troop seating is in the upstairs troop

compartment which always provides 73 available seats. The standard configurations are as follows:

- CP-1. This configuration offers 36 pallet positions and seats for 73 passengers in the troop compartment. All rollers will be up in this configuration.
- CP-2. This configuration offers a clean cargo compartment floor for floor-loaded cargo and seats for 73 passengers in the troop compartment. All rollers will be down in this configuration.
- CP-3. This configuration offers a mixed combination of palletized cargo and floor-loaded cargo in the cargo compartment and seats for 73 passengers in the troop compartment. Rollers will be positioned as the cargo dictates.

KC-10 CONFIGURATIONS

AMC currently offers two configurations for troop-cargo movement (Figures A-1 and A-2). Other configurations are available; however, they must be specifically coordinated for with AMC headquarters and affiliated ALCS. Refer to T.O. 1C-10(K)A-9.

A-2

Figure A-1. 69 Troops - 17 Pallets Configuration.

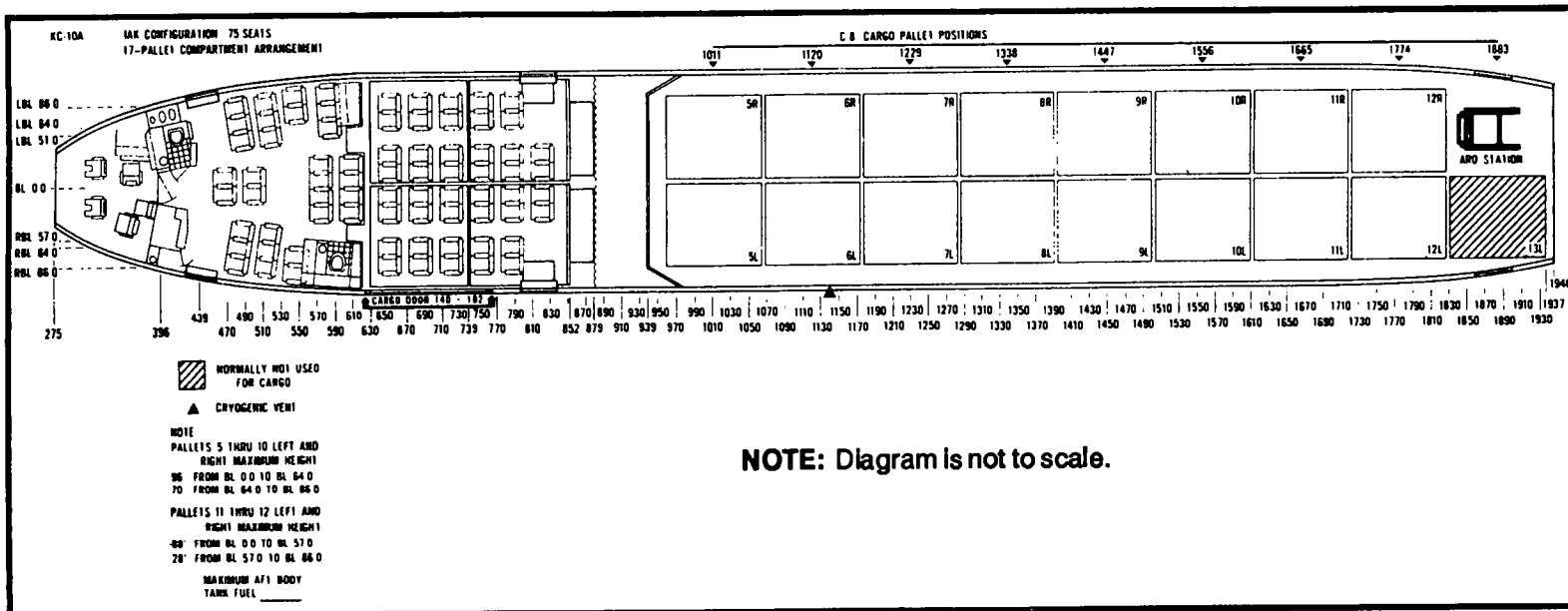
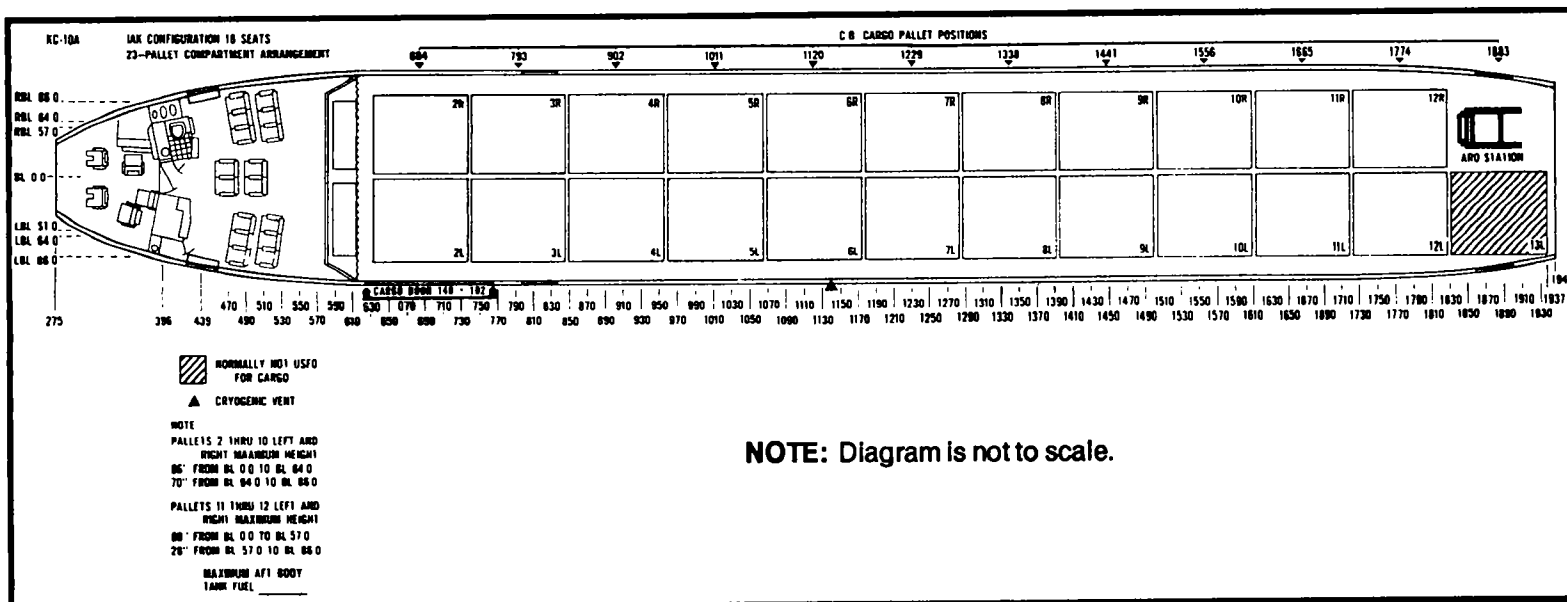
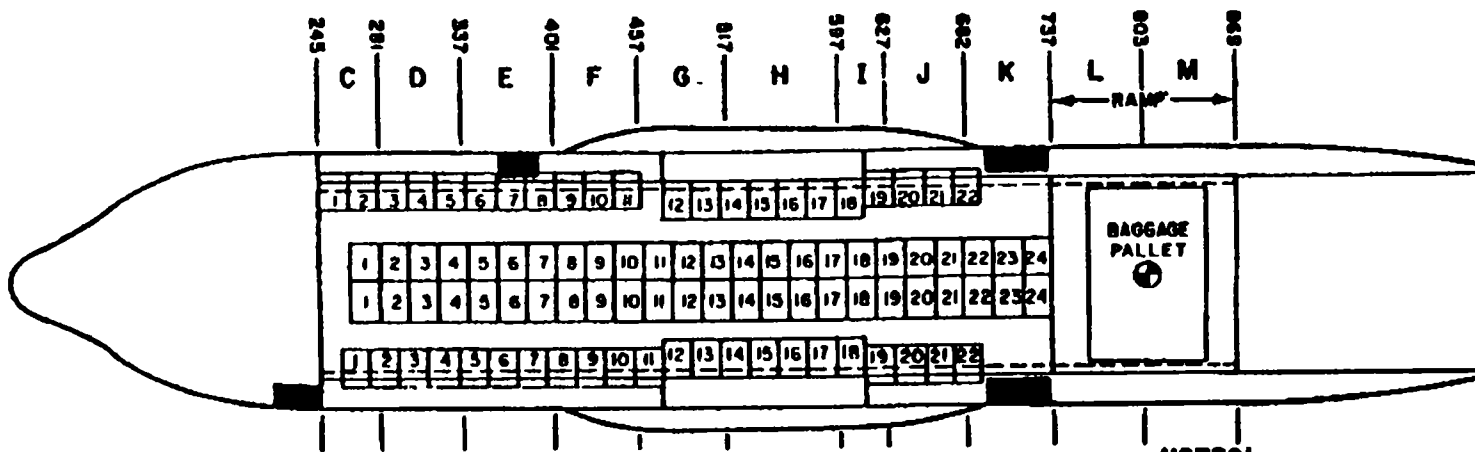


Figure A-2. 10 Troops - 23 Pallets Configuration.



*Figure A-3. C-130 Configuration P-1.



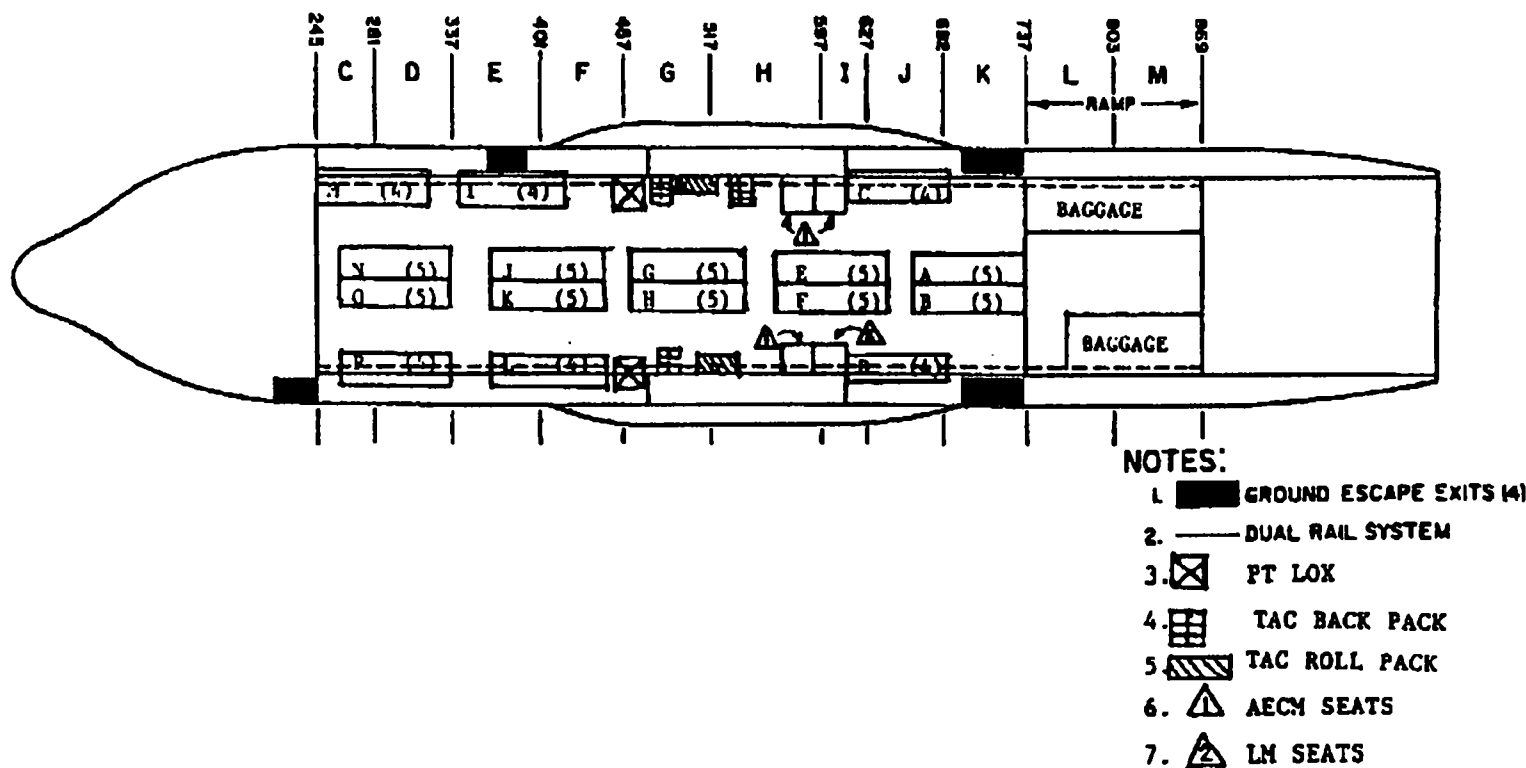
NOTES:

1. [Symbol] GROUND ESCAPE EXITS (4)
2. - - - - DUAL RAIL SYSTEM

1. Ninety-two sidewall and center aisle seats--seat belts on 20-inch centers--90 seats offered. Overwater flights are limited to a maximum of 80 total personnel, including crew. For overwater flights eliminate outboard wheel well seats.
2. Seats are numbered for identification and will be referred to as sidewall seat 1 left/seat 1 right or center aisle seat 1 left/seat 1 right.
3. Cargo floor roller conveyors are removed and stowed under center aisle seats (no more than two high).
4. Time to configure is two persons, two hours.

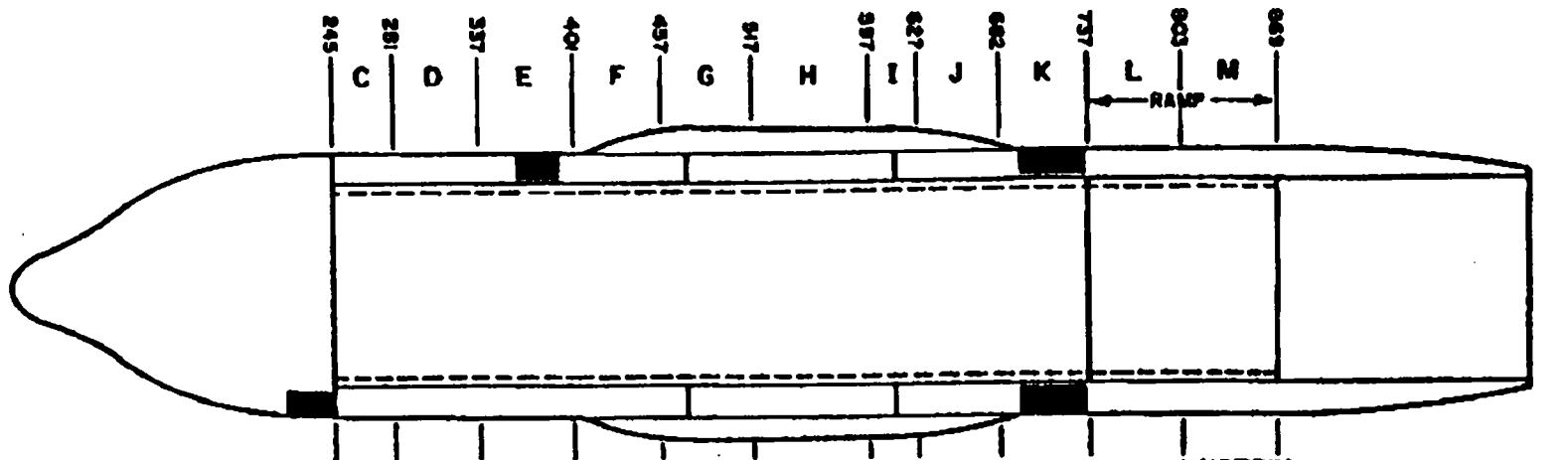
C-130 CONFIGURATIONS

*Figure A-4. C-130 Configuration AE-2.



1. This AE configuration provides 70-74 litter spaces and eight wheel well seats.
2. Wheel well seats will be installed and hooked up to the seat-back support bar. Final seat installation will be completed by AECMs.
3. Time to configure is two persons, two hours.

*Figure A-5. C-130 Configuration C-1.

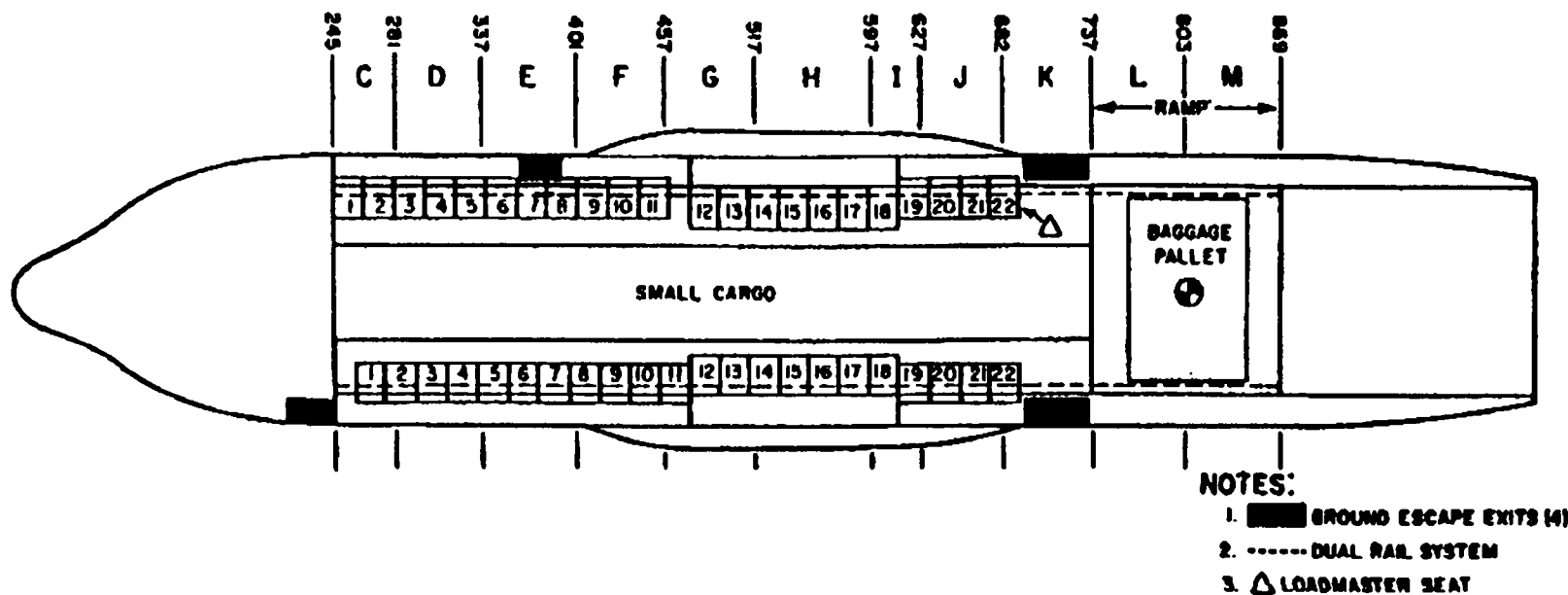


NOTES:

1. GROUND ESCAPE EXITS (4)
2. DUAL RAIL SYSTEM

1. Cargo on floor and/or rolling items.
2. Roller conveyors stowed on top of outboard rails.
3. C-1 seating is as required depending on amount and type of cargo being airlifted.

Figure A-6. C-130 Configuration CP-1.



1. Forty-four sidewall seats--seat belts on 20-inch centers--42 sidewall seats offered. Center aisle seats may be installed as required.
2. Cargo space limited to small cargo or rolling stock. Width of cargo limited to approximately 50 inches to provide passenger comfort.
3. Seats are numbered for identification and will be referred to as seat 1 left or seat 1 right, etc.
4. Roller conveyors will be removed and secured under the installed seats (no more than two high) except for the ramp sections.
5. Time to configure is two persons, one hour.

Figure A-7. C-130 Configuration CP-2.

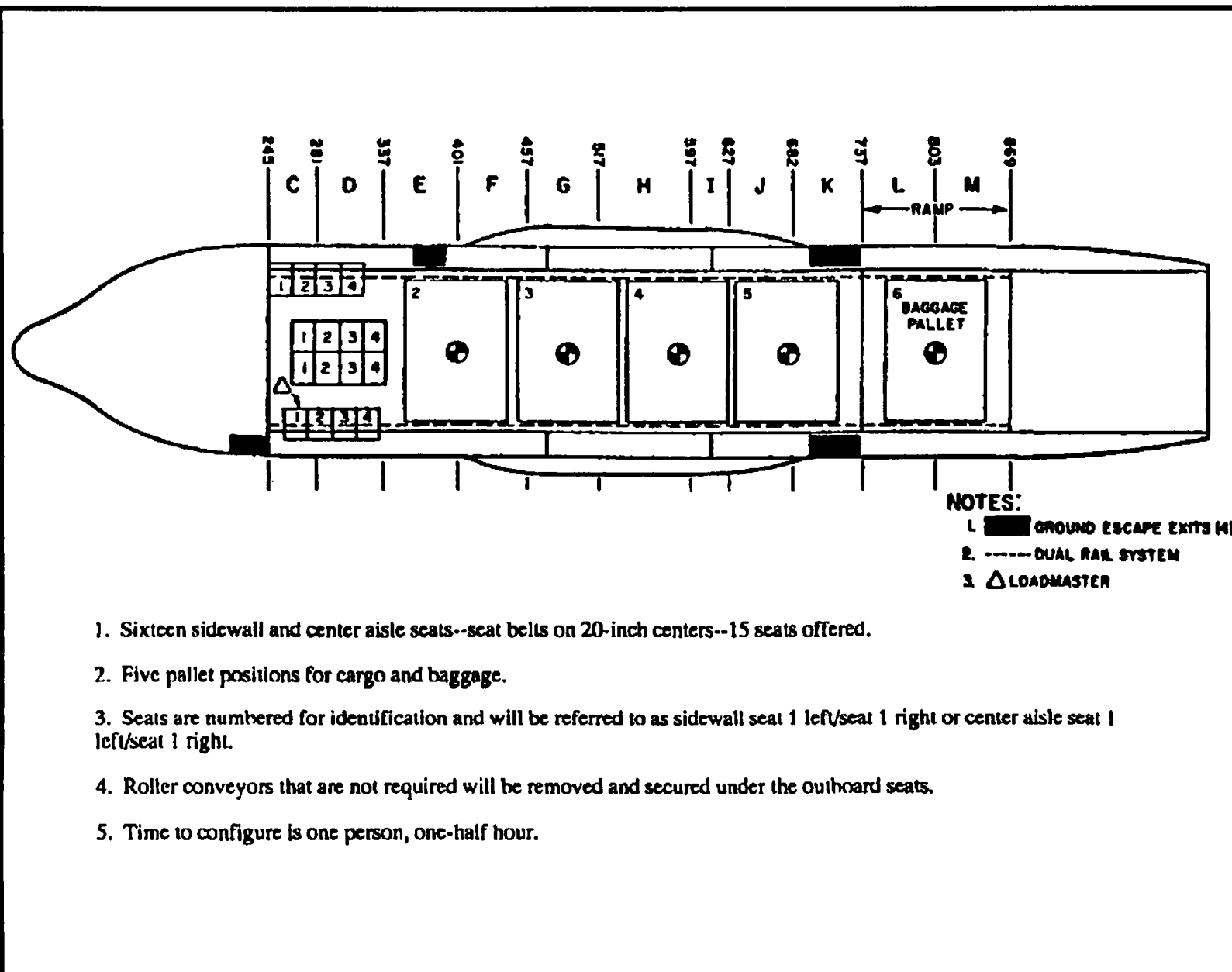


Figure A-8. C-130 Configuration CP-3.

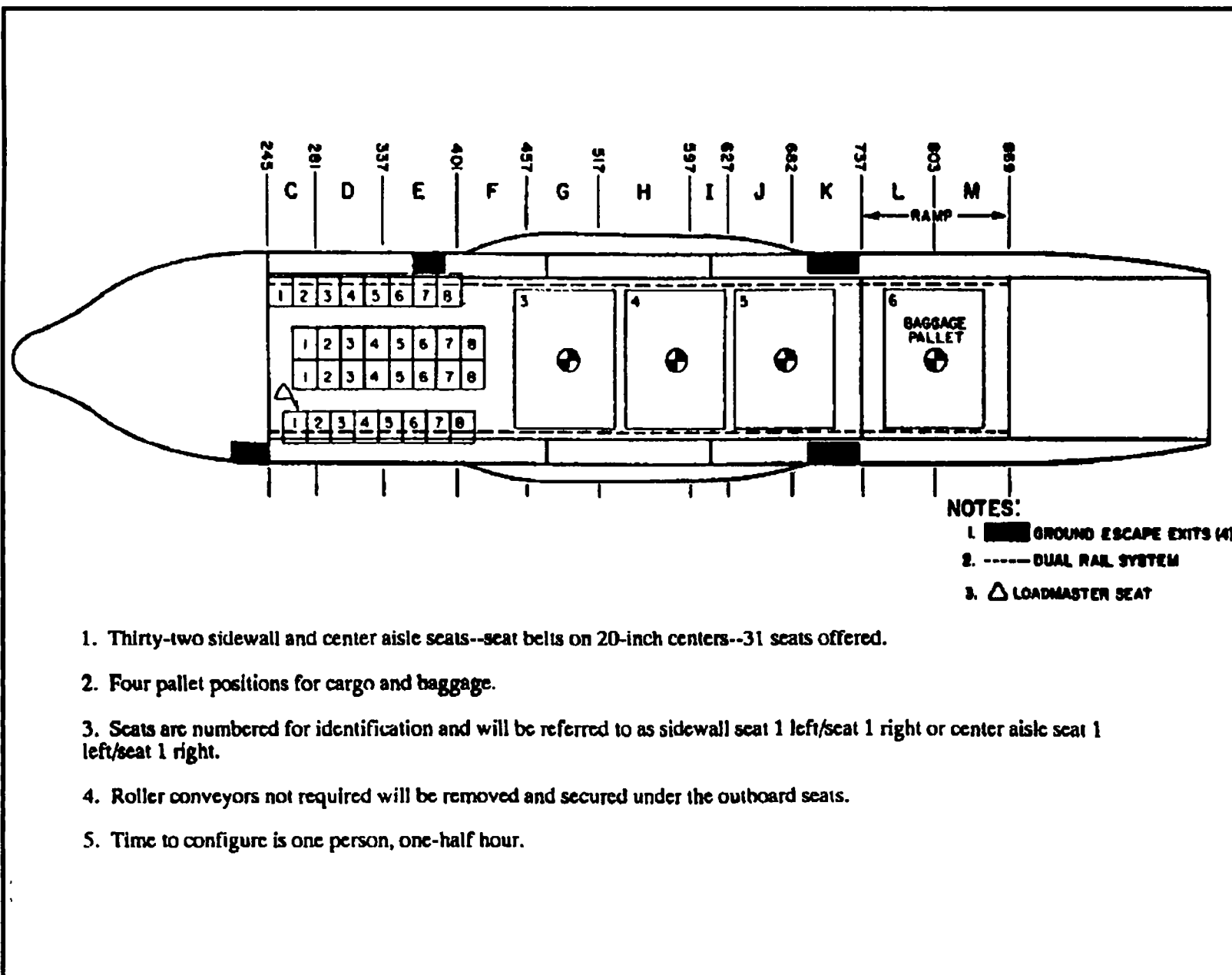


Figure A-9. C-130 Configuration CP-4.

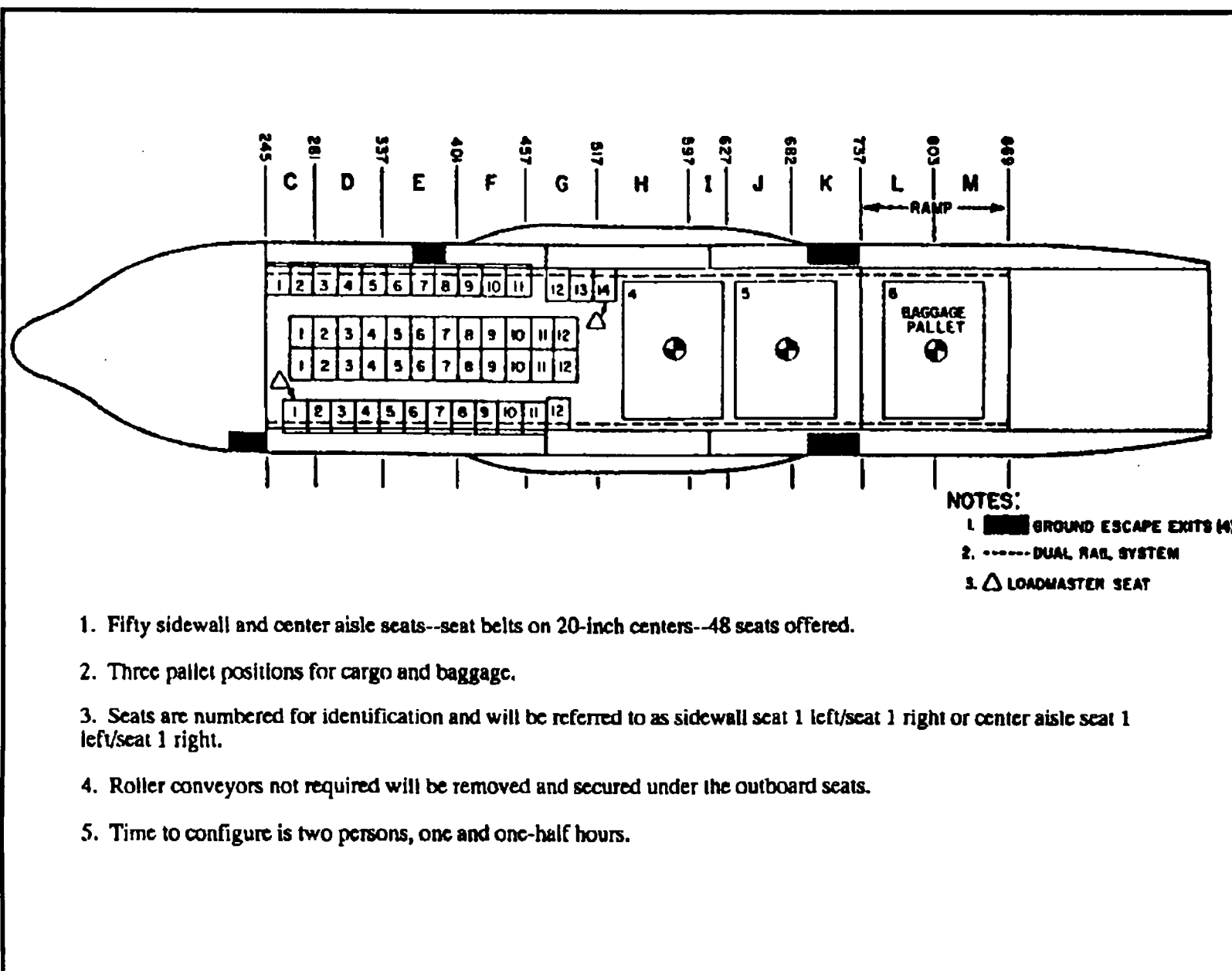
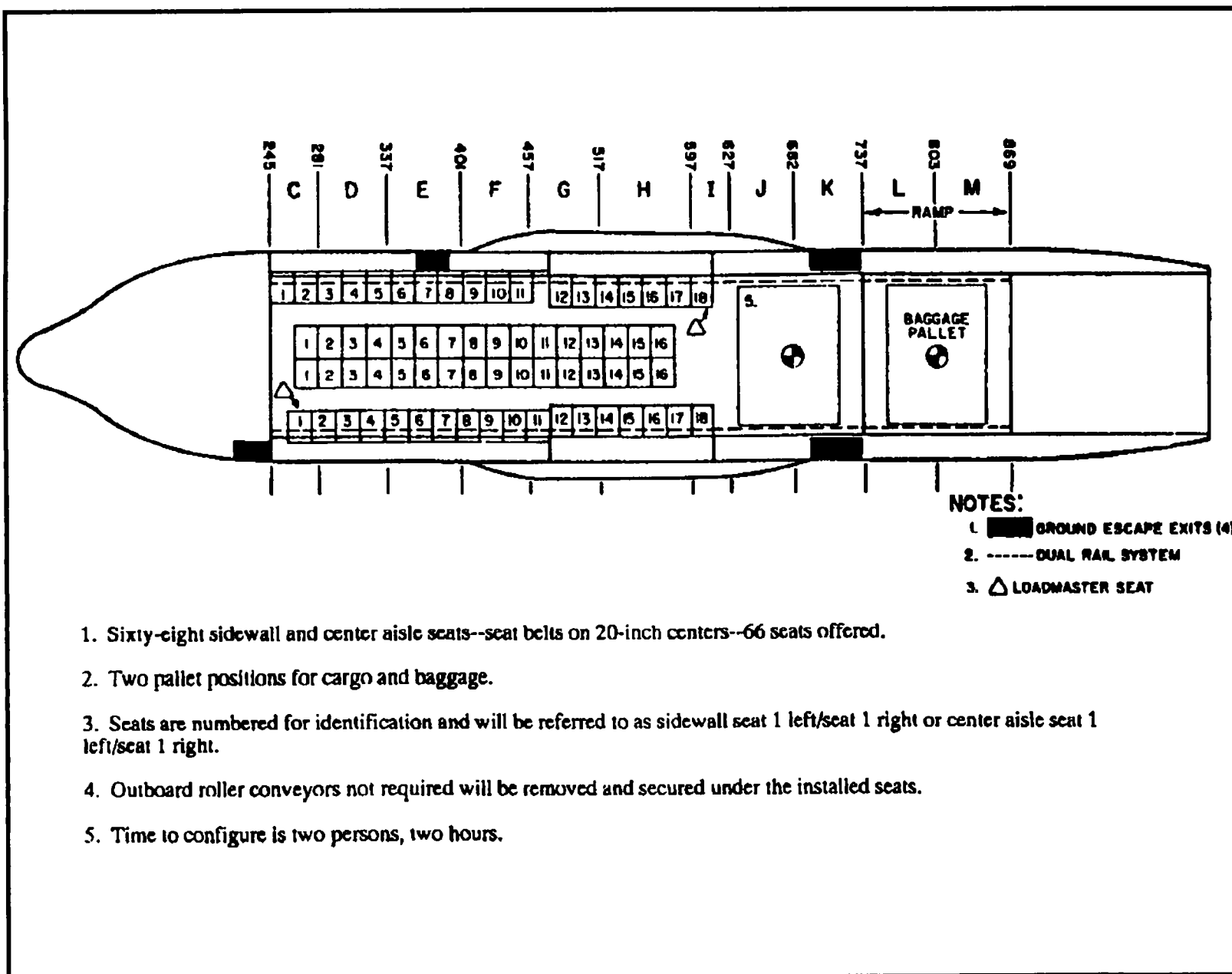
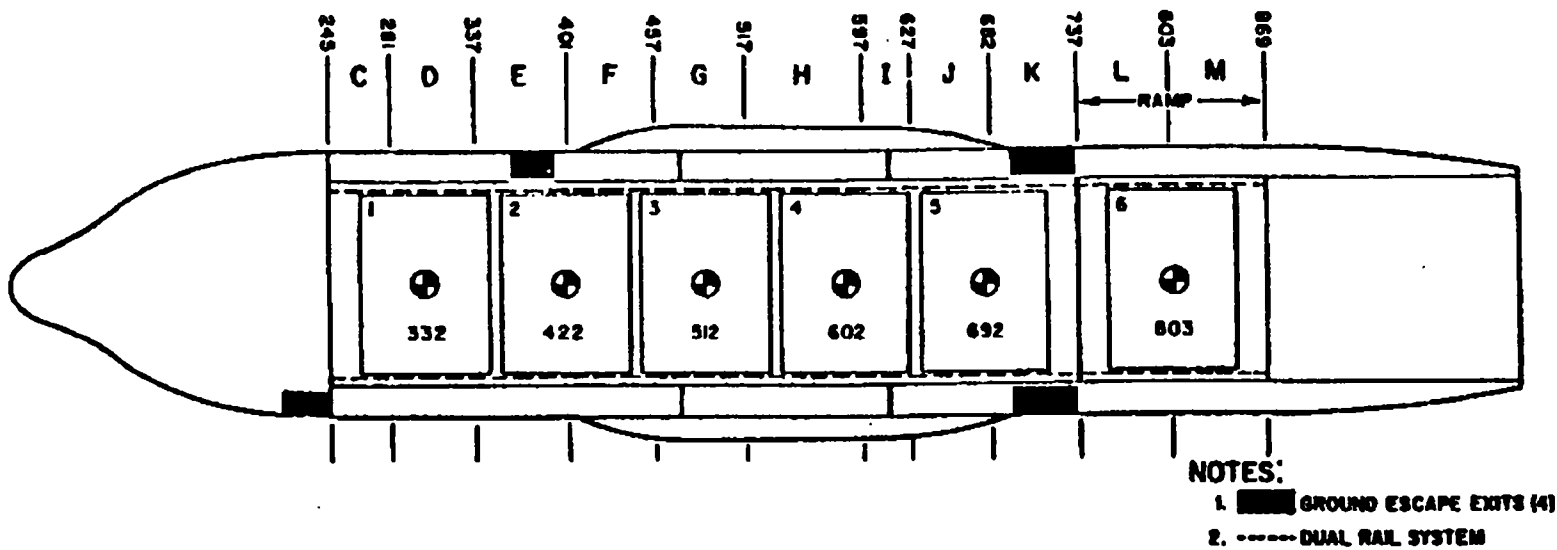


Figure A-10. C-130 Configuration CP-5.

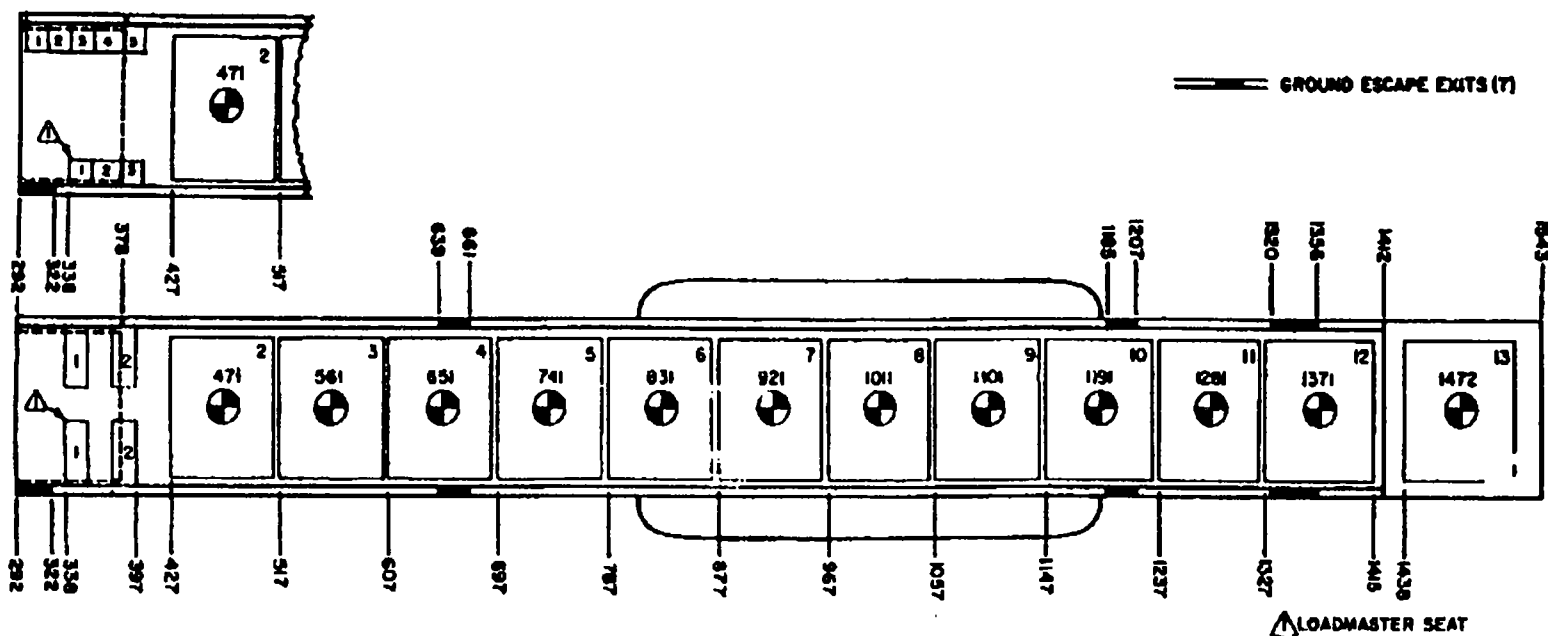


*Figure A-11. C-130 Configuration C-2.



1. Restraint rails and intermediate roller conveyors installed to provide maximum pallet utilization.
2. If cargo permits, sidewall seats may be available.
3. Time to configure is one person, one-half hour.

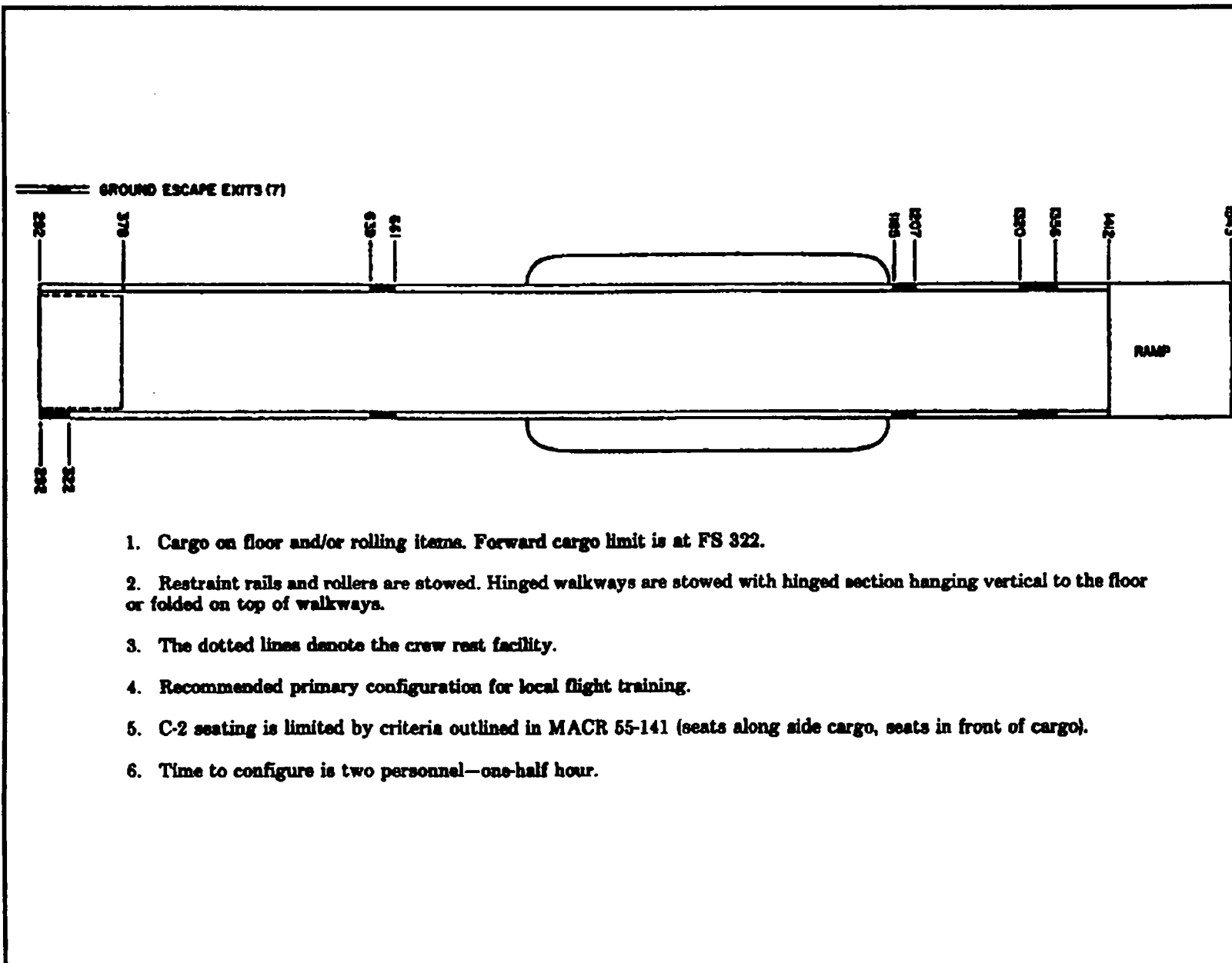
C-141 CONFIGURATIONS



1. Restraint rails down and roller conveyors up, except for the number one pallet position. Cargo on HCU-6/E pallets, maximum 12 pallets. Hinged walkways will be in the extended position. Extension shall be accomplished prior to loading.
2. The normal stacking height of cargo on single pallets on the main cargo floor is 96 inches above the surface of the pallet. The maximum stacking height of cargo on single or married pallets on the main cargo floor (pallet positions 2 through 12) are 100 inches above the surface of the pallet(s). The maximum stacking height of cargo in pallet position 13 (ramp pallet) is 76 inches above the surface of the pallet.
3. Of the eight side-facing seats installed, one is for the loadmaster and seven available for passengers. Twelve aft-facing seats may be installed in the same areas (38-inch spacing) with 11 seats available for passengers. The number of flight crew personnel will govern the number of available seats. The 30-inch spacing, as required by MACR 55-141 will apply. Install aft-facing seats, two on the right side and two on the left side, with forward most portion of seat aft of FS 340.
4. Ramp pallet is limited to 7500 pounds which includes the weight of the pallet/nets.
5. The dotted lines denote the crew rest facility.
6. Time to configure is two personnel—one hour.

Figure A-12. C-141 Configuration C-1.

Figure A-13. C-141 Configuration C-2.



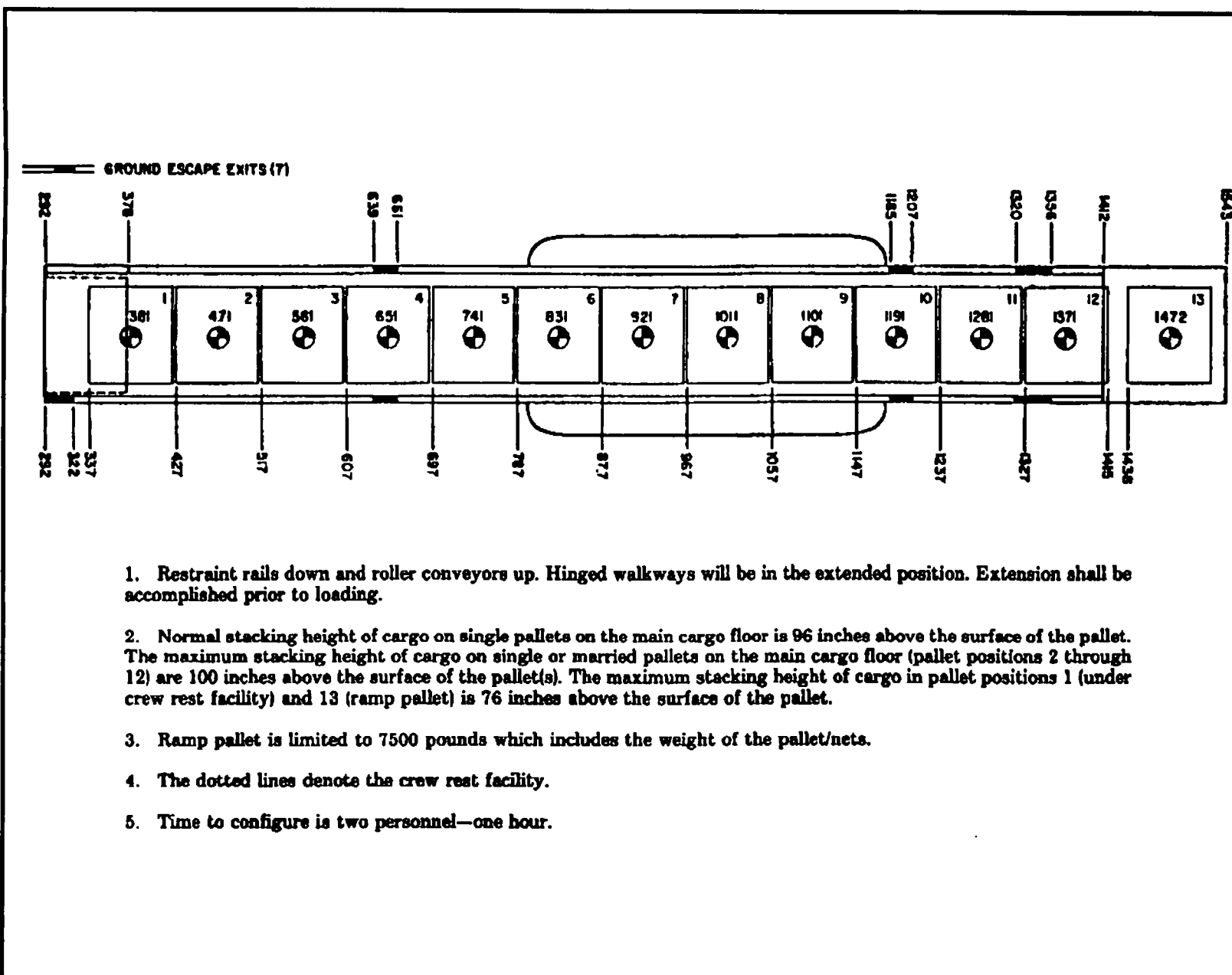
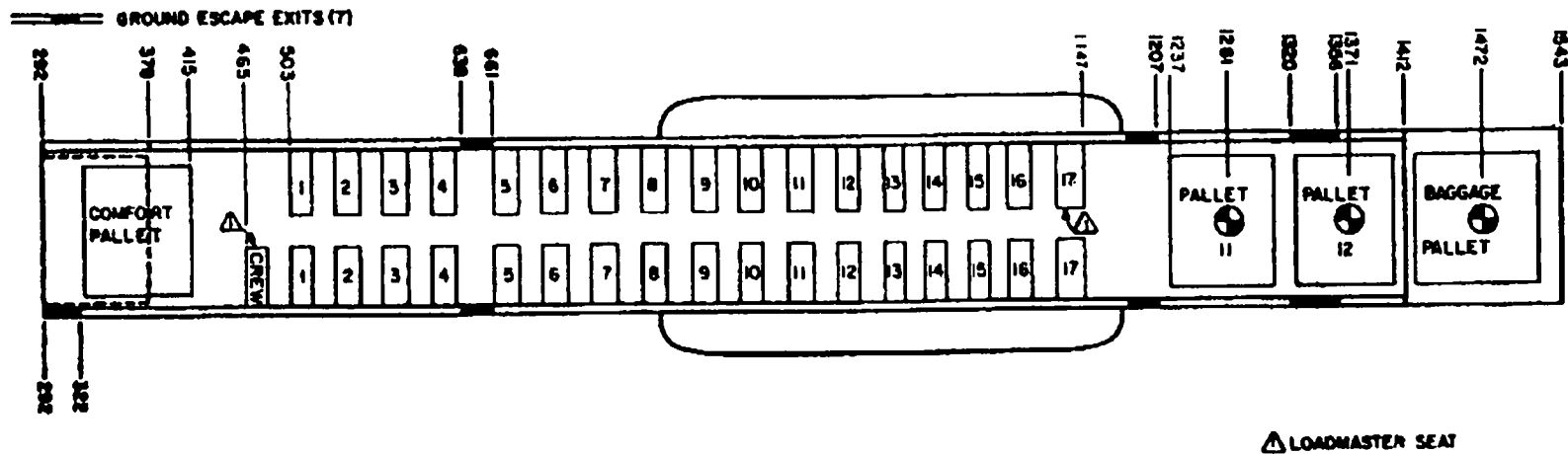


Figure A-14. C-141 Configuration C-3.

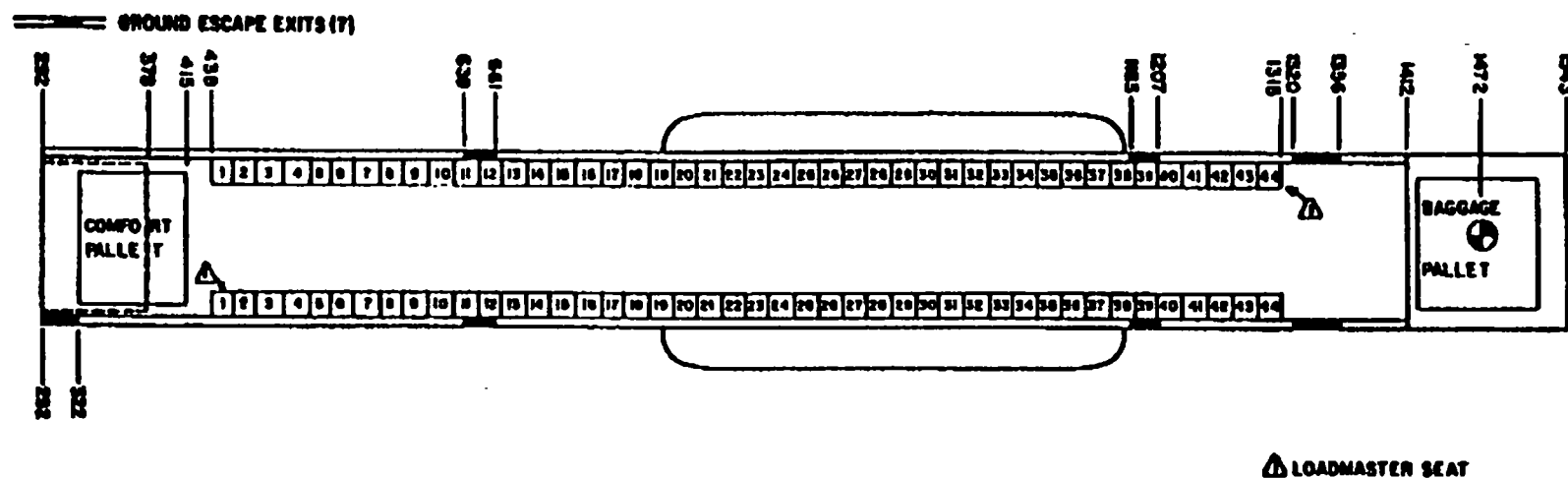
1. Restraint rails down and roller conveyors up. Hinged walkways will be in the extended position. Extension shall be accomplished prior to loading.
2. Normal stacking height of cargo on single pallets on the main cargo floor is 96 inches above the surface of the pallet. The maximum stacking height of cargo on single or married pallets on the main cargo floor (pallet positions 2 through 12) are 100 inches above the surface of the pallet(s). The maximum stacking height of cargo in pallet positions 1 (under crew rest facility) and 13 (ramp pallet) is 76 inches above the surface of the pallet.
3. Ramp pallet is limited to 7500 pounds which includes the weight of the pallet/nets.
4. The dotted lines denote the crew rest facility.
5. Time to configure is two personnel—one hour.

Figure A-15. C-141 Configuration CP-2.



1. 106 aft-facing seats—38-inch seat spacing except between rows 4 and 5 which has a 46-inch spacing for emergency evacuation; 101 passenger seats offered. Crew seat installed between FS 465-486.
2. The dotted lines denote the crew rest facility.
3. Seats are numbered for identification and will be referred to as seat 1 left or seat 1 right, etc.
4. Cargo space between stations 1237 and 1412. Two pallet positions for cargo.
5. Restraint rails and rollers are stowed where seats are shown. Hinged walkways will be stowed with hinged section hanging vertical to the floor where seats are shown. Walkways will be extended in cargo area.
6. The side-facing seats immediately in front of the forward side emergency exits and emergency gear access panels will be rolled when aft-facing seats are installed (see paragraph 3-2h).
7. Time to configure is four personnel—four hours.
8. Ramp pallet is limited to 7500 pounds which includes the weight of the pallet/nets.

*Figure A-16. C-141 Configuration CP-3.

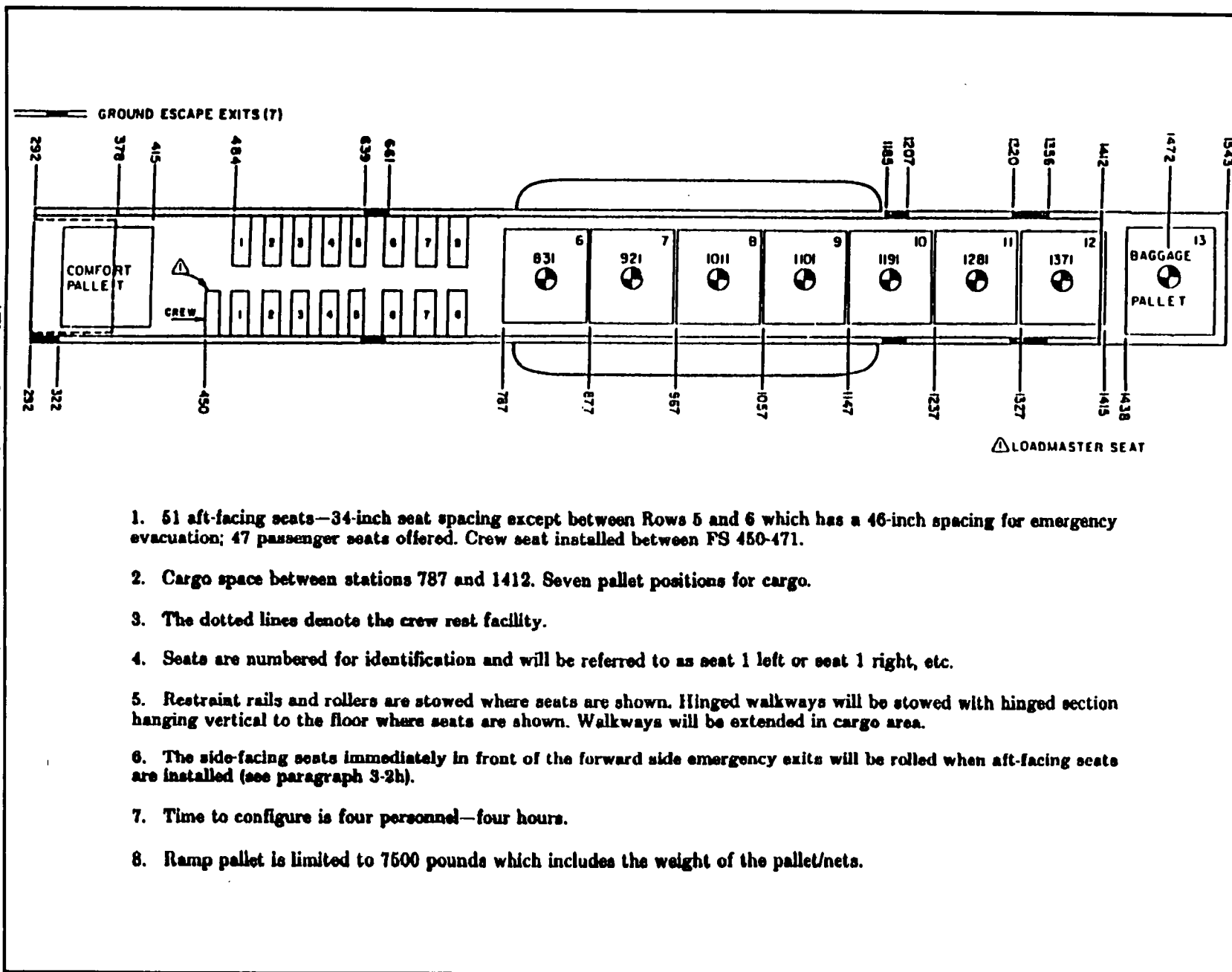


1. 88 troop seats—seat belts on 20 inch centers—86 troop seats offered.
2. Cargo space limited to small cargo. Width of cargo limited to approximately 50 inches to provide passenger comfort.
3. The dotted lines denote the crew rest facility.
4. Seats are numbered for identification and will be referred to as seat 1 left or seat 1 right, etc.
5. Restraint rails and roller conveyors may be stowed except for the comfort pallet and baggage pallet. Hinged walkways may be stowed with hinged section hanging vertical to the floor or folded on top of walkways.
6. Time to configure is four personnel—three hours.
7. Ramp pallet is limited to 7500 pounds which includes the weight of the pallet/nets.



- C1, FM 55-9**

*Figure A-18. C-141 Configuration CP-1



APPENDIX B

PREPARATION OF EQUIPMENT AND PERSONNEL

INTRODUCTION

The equipment/personnel preparation checklist will eliminate many deficiencies encountered during deployment. It will not replace established procedures in FM 55-12. However, when used with FM 55-12, the checklist should help eliminate most problems that may arise in preparing equipment for air movement.

DD FORM 2133

Units should have copies of DD Form 2133 (Figure B-1) on hand in the unit area to check items before movement to the marshaling area at the departure airfield. Follow the guidance below to complete this form.

The TALCE uses DD Form 2133 as the standard to determine the air worthiness of the cargo. The TALCE will complete and sign this form at the call forward area (CFA) joint inspection site. All cargo becomes Air Force property after successful execution of the DD Form 2133 and will be controlled by the TALCE representative at the ready line (RL).

The remainder of this appendix explains how to fill out DD Form 2133.

A. Documentation

Block 9 - Manifest/Number of Copies

This is a written inventory and record of cargo and passengers on an aircraft. (Use DD Form 2130-series, as applicable.)

It is prepared in a minimum of 7 copies for in-theater moves and 15 copies for strategic or out-of-theater moves. Distribute according to FM 55-12.

Block 10 - DD Form 1387-2 (As required)

Any potentially hazardous materials must be certified using this form; for example, corrosive, toxic, flammable, and explosive materials.

This form should be filled out in a minimum of three copies and distributed according to TM 38-250. Also, persons certifying hazardous material must follow guidance in TM 38-250.

Block 11 - Hazardous Cargo Compatibility

Check hazardous materials being airlifted on the same aircraft for compatibility. Refer to TM 38-250, Attachment 1.

Block 12 - Load Lists/Custodian Transfer Forms

Cargo custodians should have a listing identifying the items loaded aboard a truck or trailer or on the 463L pallets.

If no user personnel will accompany the cargo and cargo requires special security precautions while en route, use AF Form 127 (Traffic Transfer Receipt).

This form provides a hand-to-hand receipt record of the handling of the shipment from origin to destination.

B. Vehicles/Non-Powered Equipment

Block 13 - Clean

Clean items of all dirt, trash, pests, and oil, fuel, or corrosive residue. Steam clean, if necessary, especially when returning from out-of-country moves.

If vehicles and equipment are not clean, the US Department of Agriculture will place the items in quarantine.

Remove all oil- and fuel-soaked rags, as this would present a hazard when confined on an aircraft.

Ensure all vehicle tires are free of rocks and pebbles. The aircraft floor is aluminum, a soft metal. The rocks and pebbles could rip or dent the aircraft floor.

JOINT AIRLIFT INSPECTION RECORD (See Instructions on Reverse Side)										PAGE OF PAGES	
1 UNIT BEING AIRLIFTED				2 DEPARTING AIRFIELD				3 DATE (Day, Month, Year)			
4 TYPE MODEL SERIES AIRCRAFT AND SERIAL NO				5 MISSION NUMBER		6 LOAD/CHALK NO		7 TIME COMPLETED		8 ALICE/RECT	
LEGEND (Mark blocks after each item as follows)				INCREMENT / SERIAL / BUMPER NUMBER AND TYPE							
✓ = SATISFACTORY X = UNSATISFACTORY IF NOT APPLICABLE - LEAVE BLANK											
A. DOCUMENTATION											
9 MANIFESTS / NUMBER OF COPIES											
10 DD FORM 1387.2 (As required)											
11 HAZARDOUS CARGO COMPATIBILITY											
12 LOAD LISTS / CUSTODIAN TRANSFER FORMS											
B. VEHICLES / NON-POWERED EQUIPMENT											
13 CLEAN											
14 FLUID LEAKS											
15 MECHANICAL CONDITION											
a ENGINE RUNS											
b BRAKES OPERATIONAL											
16 BATTERY											
a SECURE NO LEAKS											
b IF DISCONNECTED - POST / CABLES TAPED											
17 FUEL TANK(S)											
a ONE-HALF (1/2) TANK											
b ONE-FOURTH (1/4) TANK											
c DRAINED (As required)											
d FUEL TANK CAPS INSTALLED											
18 JERRY CANS (Secure, Fuel Level, Seals)											
19 DIMENSIONS (Fits A/C Profile or Contour)											
20 CENTER OF BALANCE (Both Sides)											
21 SCALE WEIGHT (Both Sides)											
22 AXLE WEIGHTS (Both Sides)											
23 TIEDOWN POINTS (Serviceable)											
24 PINNLE HOOKS / CLEAVES											
a SERVICEABLE											
b SAFETY PIN ATTACHED											
25 VEHICLE EQUIPMENT SECURE (Tools, tires, antennas, etc.)											
26 LOX / NITROGEN CART (Vent Rxt)											
27 TIRE PRESSURE											
28 SHORING (Rolling, Parking, Sleeper)											
29 ACCOMPANYING LOAD											
a WITHIN VEHICLE RATED CAPACITY											
b SECURE TO VEHICLE											
C. PALLETS											
30 CLEAN											
31 SCALE WEIGHT (88 inch Side)											
32 DIMENSIONS (Fits A/C Profile or Contour)											
33 CARGO PROPERLY SECURED											
a NETTED											
b CHAINED											
34 COUNAGE (3 Pcs Per Pallet)											
D. HELICOPTERS (Flyaway)											
35 BATTERY (Disconnected/Taped)											
36 FUEL QUANTITY (Gallons)											
37 CENTER OF BALANCE (Both Sides)											
38 SCALE WEIGHT (Both Sides)											
39 SHORING (Rolling, Parking)											
40 SPECIAL LOADING EQUIPMENT											
41 REMARKS											
The above listed vehicles / non-powered equipment have been inspected for proper shipping configuration in accordance with Chapter 3, AFR 71-4, TM 38-250 / NAVSUP PUB 505 (REV) / MCO P4030 19D / DLAM 4145 3.											
42 TRANSPORTED FORCE INSPECTOR (Signature/Rank/Unit of Assignment)						43 TRANSPORTATION FORCE INSPECTOR (Signature/Rank/Unit of Assignment)					

DD Form 2133, NOV 86 Previous editions are obsolete.

Figure B-1. DD Form 2133.

Block 14 - Fluid Leaks

Make sure there are no fuel, oil, hydraulic, brake, or cooling system leaks.

A leak is a loss of fluid or fuel at a rate that is readily detected or seen. Five drops or more per minute from a cooling system, crank case, or gear case is considered a leak. Fuel or brake system leaks, no matter how minor, will result in the item being frustrated. A damp or discolored seal need not be considered a leak unless the above conditions exist.

Block 15 - Mechanical Condition

- a. Engine runs.
- b. Brakes are operational:
 - Foot brake.
 - Emergency brake.

Block 16 - Battery

Properly secure the battery with hold-down bracket to include cable routing and insulation. The battery must not be allowed to short out with the metal casing/compartment. All battery cell caps must be in place and secure.

If the battery is disconnected, tape the post/cables to prevent sparks from contacting metal.

Check batteries for cracks or leakage of battery acid.

Block 17 - Fuel Tank(s)

*a. One-Half (1/2) Tank. Self-propelled vehicles may be transported with a maximum of three-quarters of a tank of fuel when placed on the cargo floor of the aircraft (with a copy of HQ AFMC message 301700Z DEC 92). Without the message, vehicles are limited to one-half tank regardless of location. Vehicles placed on the ramp will not exceed one-half tank of fuel, with the filler opening positioned on the up high side of the ramp.

*b. One-Fourth (1/4) Tank. Not applicable.

c. Drained (As required). Equipment that is mounted on a single axle (trailer) that is disconnected from its prime mover (truck) and loaded with its tongue resting on the aircraft floor must be drained but need not be purged.

d. Fuel Tank Caps Installed. There are two types of fuel tanks: pressurized and non-pressurized. The type will be stenciled onto the gas cap. When transporting the different types of fuel tanks, take the following steps:

- * . On nonpressurized tanks, ensure the caps are in the locked position.
- * . On pressurized tanks, ensure the caps are in a semilocked position, with about one-quarter turn to open. This will allow pressure to escape from the tank while in flight.

Block 18 - Jerry Cans (Secure, Fuel Level, Seals)

Secure jerry cans, DOT 5L, in racks designed to hold them and prevent movement. In this case, no hazardous cargo certification will be required when moving under a Chapter 3 move of TM 38-250.

*Prevent metal-to-metal contact between jerry cans not secured in racks by using cushioning material or fiberboard (MRE box sleeves). DD Form 1387-2 will be required under a Chapter 3 move of TM 38-250.

Palletized jerry cans with fuel are not acceptable for military air shipments.

Jerry cans are authorized for transporting flammable liquid fuel stock in quantities when combined with the fuel shipped in the tanks of the vehicles or equipment does not exceed a two-full-tank supply. For example, a vehicle on the ramp of a C-130 has a 10-gallon fuel tank. You are limited to 5 gallons because of the ramp restrictions. You would be allowed to carry three jerry cans of fuel.

Maximum amount of fuel is 5 gallons or 1 inch below filler neck.

All jerry cans must have serviceable seals before use for air shipment. To check seals, fill jerry cans and turn upside down. If fuel leaks, replace the seals. If the seals leak, the jerry cans will be frustrated. Jerry can are authorized for shipment only between CONUS stations.

Block 19 - Dimensions (Fits A/C Profile or Contour)

The dimensions must be within aircraft loading envelope capabilities. Measure the length, width, and height of items to ensure that they do not exceed aircraft limits.

Mirrors that extend beyond the body of the vehicle must be folded in.

Some vehicles will require that the canvas and bows be removed before loading.

Antennas, exhaust stacks, and other reducible objects may require removal before loading.

Block 20 - Center of Balance (Both Sides)

CB must be accurately computed and marked on both sides as shown in Appendix G of FM 55-12.

The suggested marking method is with tape and grease pencil. Place tape that is at least 1 by 3 inches vertically at the CB of the item. Indicate the center of balance and the distance from the front axle in inches. Place masking tape that is at least 1 by 3 inches horizontally at the CB of the item. Place this tape directly above the vertical tape to form a T and indicate the gross weight of the item. Apply these markings only after the secondary load is applied and the vehicle is weighed on scales. You should keep a journal of axle weights, distances, and CB data in case tape or grease pencil markings become illegible or fall off during the move.

Block 21 - Scale Weight (Both Sides)

The scale weight must be accurately determined and marked on both sides of the item, as indicated above.

Block 22 - Axle Weights (Both Sides)

The shipping unit will determine the weights of the axles by actually weighing the vehicle.

Wheel and axle weight must be within allowable limits for the cargo floor.

Gross axle weight(s) must be marked on both sides of the vehicle above the axles.

Block 23 - Tiedown Points (Serviceable)

Ensure the serviceability of each tiedown point, such as clevis or lifting ring. Ensure no cracks are visible and safety pins or locking nuts are installed, if applicable.

Block 24 - Pintle Hooks/Clevises

a. Serviceable. If the vehicle or equipment has a pintle hook or clevis installed, check them for serviceability and make sure no cracks are present.

b. Safety Pin Attached. Install safety pins for pintle hooks if planning to push or tow a trailer on or off the aircraft.

Block 25 - Vehicle Equipment Secure (Tools, tires, antennas, etc.)

Secure axe, pick, and shovel.

Secure spare tire and tools.

Secure radios and fire extinguisher.

Block 26 - Lox/Nitrogen Cart (Vent Kit)

Ensure the vent kit has all necessary hoses, clamps, and tools to connect the item to the aircraft vents, as required.

Ensure hoses are clean of all oil, grease, dirt, and so forth.

Block 27 - Tire Pressure

Underinflated tires may cause the rim to bottom out during turbulence and cause damage to the aircraft floor.

Tires should be inflated to within 10 percent of the stenciled tire pressure, not to exceed 100 psi.

Do not deflate tires to decrease vehicle/equipment height to gain clearance when loading aboard the aircraft.

Block 28 - Shoring (Rolling, Parking, Sleeper)

(For specific guidance on shoring requirements, refer to Chapter 6, Load Shoring.)

Rolling shoring is required for most track-type vehicles. It protects the aircraft floor as the vehicle is moved into position in the cargo compartment.

Parking shoring is used to protect the aircraft floor from metal-to-metal contact or when an item exceeds the psi limitations of the aircraft floor.

Sleeper shoring is required for vehicles weighing 20,000 pounds or more equipped with tires that are not designed for highway travel, such as the 10K rough terrain forklift. This shoring is stacked under the axle/chassis and near each wheel to prevent bouncing during flight.

Block 29 - Accompanying Load

- a. Within Vehicle Rated Capacity. Do not allow the accompanying load to exceed the rated cross-country capacity of the vehicle (found on vehicle data plate/TB 55-46-1).
- b. Secure to Vehicle. Use a minimum of 1/2-inch-diameter hemp or cotton rope (no nylon). Secure in lateral, longitudinal, and vertical directions. Metal banding may also be used to secure the accompanying load, as long as the load is *not hazardous material*. Identify hazardous material so it will be readily accessible during flight.

C. PALLETS

(Refer to Appendix B for specific guidance on 463L pallets.)

Block 30 - Clean

Before loading, thoroughly clean all pallets of all mud, dirt, and oil.

Block 31 - Scale Weight (88 Inch Side)

The pallet gross weight shall be marked by a card on each short side giving accurate weight for the pallet.

Block 32 - Dimensions (Fits A/C Profile or Contour)

Usable cargo surface on pallet:

- Length - 84 inches.
- Width - 104 inches.
- Height - 96 inches. (Comply with specific aircraft pallet profile requirements.)

Block 33 - Cargo Properly Secured

- a. Netted. Two side nets are attached to tie-down rings on the pallet. Cargo height may preclude the use of side nets, at which time a top net only may be used with additional restraint being applied with the 5,000-pound cargo straps found on the aircraft when it arrives. When using all three nets, the top net will be attached to rings on the two side nets.
- b. Chained. Certain items may be chained to the pallet instead of using nets; for example, canned engines and generators.

Block 34 - Dunnage (3 Pcs Per Pallet)

3-point dunnage:

- Dunnage is a minimum of 4 by 4 by 88 inches.
- Dunnage is placed under the 463L pallet before loading cargo on the pallet.
- Dunnage is installed in the correct direction (for forklift pickup).

D. Helicopters (Flyaway)

Block 35 - Battery (Disconnected/Taped)

Before disconnecting the battery or batteries, the fuel level must be verified by the Air Force inspector. Once the fuel level has been checked, proceed to fasten the battery or batteries securely in the holder provided, with the terminals disconnected

and protected in such a manner as to prevent damage or short circuits.

Block 36 - Fuel Quantity (Gallons)

Fuel is at a maximum of three-quarters of a tank full or 150 gallons, whichever is less.

Block 37 - Center of Balance (Both Sides)

CB is accurately computed and marked on both sides with masking tape and grease pencil.

Block 38 - Scale Weight (Both Sides)

Use portable or platform scales to accurately determine the gross weight. Do not use book weights. Mark gross weight on both sides with tape and grease pencil.

Block 39 - Shoring (Rolling, Parking)

Ensure all required shoring is provided and in good condition.

Block 40 - Special Loading Equipment

Transport wheels, hydraulic carts, air carts, and so forth, to aid in loading and unloading the helicopter(s). Use any other associated equipment that may be deemed necessary for airlifting helicopters.

Block 41 - Remarks

Make any additional remarks not specifically addressed in Blocks 9 through 40, as appropriate.

Record corrections to deficiencies noted in Blocks 9 through 40.

APPENDIX C

AIR MOVEMENT PLANNING WORKSHEET**INTRODUCTION**

The Air Movement Planning Worksheet (Figure C-1) is used to prepare a consolidated list of all unit equipment and personnel. This is a recommended format only. Units may locally design and reproduce their own version.

List all dimensions and cargo loads of the vehicles. First, measure and weigh the vehicles as shown in FM 55-12 to ensure that they have not been modified from the standards listed in TB 55-46-1. Next, check the unit property book, which lists the proper Army nomenclature for the vehicles and tells the full authorized amount of equipment. To find how many items of equipment are authorized, refer to the unit table(s) of organization and equipment. Even if the unit is short some equipment, include it in the air movement plan. When the unit deploys or is alerted to deploy, the equipment shortages may be filled. Refer to vehicle load cards to find how much cargo is loaded into each cargo truck.

INSTRUCTIONS

Fill out the Air Movement Planning Worksheet as follows:

Block 1 - Unit/Organization

Enter the unit/organization for which the form is being filled out.

Block 2 - Total Personnel

Enter the total number of personnel scheduled or planned for deployment.

Drop down to the PAX column in Block 2, and enter the number of personnel scheduled or planned for each aircraft load or chalk.

Under the Chalk column, enter the chalk number for each aircraft carrying personnel. This chalk number must correspond with the scheduled or planned number of personnel in the adjacent column.

Under the Plt/Sec column, enter the platoon or section from which the personnel are assigned.

Block 3 - Equipment

- a. Model Number. Enter the model number, such as M35A2, of each item.
- b. Description Type. Enter the description, such as 2 1/2-ton truck, cargo, of each item.
- c. ID No. Enter the ID, such as T-7, of each item.
- d. TOE Line No. Enter the TOE line number, such as X40009-02, of each item.

Block 4

- a. Length. Enter the actual length in inches of each item.
- b. Width. Enter the actual width in inches of each item.
- c. Height. Enter the actual height in inches of each item.

Block 5

- a. Empty Weight. Enter the empty weight of the item of cargo. If the item is a 463L cargo pallet, this entry would be 355 pounds (pallet and nets).
- b. Cargo. Enter the cargo weight only.
- c. Planned Weight. Enter the planned weight (gross weight) for shipment.

Block 6 - Axle Weights

Enter the front, intermediate, and rear axles' weights in these blocks.

Block 7

Enter the load or chalk number under the applicable type aircraft (C-130, C-141, C-5, KC-10) for each item of equipment listed.

Figure C-1. Sample Format of an Air Movement Planning Worksheet.

1. UNIT/ORGANIZATION JOINT TASK FORCER VECTOR														AIR MOVEMENT PLANNING WORKSHEET														PAGE 1 OF 2	
2. TOTAL PERSONNEL 98			3. EQUIPMENT				4.			5.			6.			7.													
PAX	CHALK	FLT/SEC	a. MODEL NUMBER	b. DESCRIPTION TYPE	c. ID NO.	d. TOE LINE NO.	a. LENGTH	b. WIDTH	c. HEIGHT	a. EMPTY WEIGHT	b. CARGO	c. PLANNED WEIGHT	AXLE WEIGHTS					C-130	C-141	C-5	KC-10								
													FRONT	INTERMEDIATE AXLE								REAR							
													2	3	4	5													
20	1		M548A1	CARRIER CARGO STRAC	C-6	D11049-06	223	104	77	17060	9340	26400	(5 AXLE VEHICLE)																
6	2		M998	TRK UTILITY 1 1/2 Ton	C-1	T61494-01	187	96	74	5280	1620	6800	3400									1							
50	3		M998	TRK UTILITY 1 1/2 Ton	C-2	T61494-01	187	96	74	5280	1620	6900	3400									1							
22	4		M998	TRK UTILITY 1 1/2 Ton	C-4	T61494-01	187	96	74	5280	1620	6900	3400									1							
			M911	TRK 8X6 TRACTOR	E-12	T61035-01	370	115	142	38233		38300	16000	11150									3						
			M747	STLR 60 Ton LOWBED	T-12	870061-01	515	137	114	31679		32000	9900	6100	6000	5000							3						
			D-8K	TRACTOR PTRAC W/RTR	E-9	W88699-01	321	156	135	86422		86500											3						
			M930 W/WN	DUMP TRK 5 TON	E-6	X42845-24	289	98	121	24626		24700	10300	7200									4						
			M930 W/WN	DUMP TRK 5 TON	E-4	X42845-24	289	98	121	24626		24700	10300	7200									3						
			M998	TRK UTILITY 1 1/2 TON	K-2	T61494-01	187	96	74	5280	720	6000	2500										4						
			613B	ELEVATING SCRAPER	E-10	N/A	393	104	121	30510		30600	12000										4						
			M978	TANKER 2500 GAL	E-14	T87243-01	401	96	112	38165		39000	10700	11700	8600								4						
			130-C	ROAD GRADER	E-16	G74783-01	327	95	127	31300		31300	9300	11000									4						
			645	WHEELED SQWIK LOAD	E-17	L76556-01	283	102	130	25490		25500	12000										4						
			M936 W/WN	WRECKER TRK 5 TON	CS-7	X63299-24	362	97	120	38165		38200	12000	13000									4						
			M925 W/WN	TRK CARGO D/S 5 TON	CS-11	XA0931-08	327	98	87	22458	5062	27500	10500	8500								2							

FORM 100-1000 1 Apr 82

Replaces TCPR Form 100-1000, 1 May 82, which is obsolete.

12034-09

APPENDIX D

463L CARGO SYSTEM

INTRODUCTION

The 463L cargo system encompasses all phases of cargo loading including materials-handling equipment, cargo-loading platforms, restraint equipment, and in-aircraft systems. The 463L system is the Air Force standard for moving concentrated cargo.

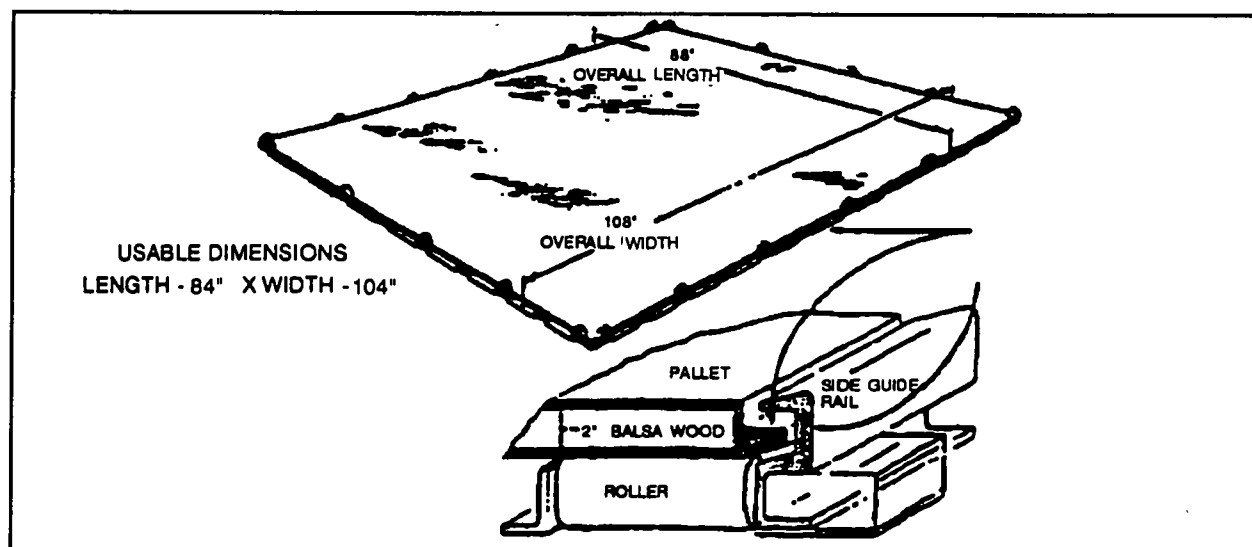
DUAL-RAIL SYSTEM

The dual-rail system is installed in all airlift or 463L-capable military aircraft. This system consists of rows of rollers that allow the palletized cargo to easily move into the aircraft. Many of these rollers are stowable to convert the cargo deck to a flat, clear loading surface for wheeled cargo. The side rails guide the pallets into the aircraft and provide lateral and vertical restraint. These rails are equipped with detent locks that hold the pallet securely in place once inside the aircraft. These locks also prevent the forward and aft movement of pallets during flight.

463L PALLET CONSTRUCTION

*The 463L pallet (Figure D-1) is made of corrosion-resistant aluminum with a soft wood or

fiberglass core and is framed on all sides by aluminum rails. The rails have 22 tie-down rings attached with 6 rings on each long side and 5 rings on each short side. Each ring has a 7,500-pound restraint capacity. The rails also have indents (notches) that accept the detent locks located on numerous types of materials-handling equipment and on all airlift-capable aircraft. The overall dimensions of the 463L pallet are 88 inches long by 108 inches wide by 2 1/4 inches thick. However, the usable dimensions of the upper surface are 84 inches wide by 104 inches long. This allows 2 inches around the periphery of the pallet to attach straps, nets, or other restraint devices. An empty 463L pallet weighs 290 pounds (355 pounds with a complete set of nets) and has a maximum load capacity of 10,000 pounds. The maximum pounds per square inch for the 463L pallet is 250 pounds. If a load exceeds this limitation, then shoring must be used to spread the load over a larger area.



*Figure D-1. 463L Master Pallet Construction.

463L PALLET NETS

There are three nets to a set (Figure D-2): one top net (yellow) and two side nets (green/black). The side nets attach to the rings of the 463L pallet and the top net attaches by hooks to the rings on the side nets. These nets have multiple adjustment points and may be tightened to conform snugly to most loads. A complete set of 463L nets provides adequate restraint for a maximum of 10,000 pounds of cargo when properly attached to a 463L pallet. For 463L pallets that do not exceed 45 inches in height or 2,500 pounds, a single top net will be used to secure the load. When a top net is used, the belly band (Figure D-2) must not be more than 8 inches from the top of the pallet surface. As stated previously, the 463L pallet has a maximum height of 96 inches restraining 10,000 pounds. If the pallet exceeds 96 inches but is less than 100 inches, a maximum weight of 8,000 pounds is allowed. A complete set of nets weighs 65 pounds.

It is important to inspect the pallets and nets for serviceability before use. Failure to use serviceable systems will result in inspection failure during the joint inspection. Refer to the checklist at the end of this appendix for inspection guidance. Return questionable components to the Air Force/ITO for proper disposal.

463L PALLET BUILDUP

Palletize cargo from the heaviest to the lightest (Figure D-3). Distribute large and heavy objects from the center of the pallet outwards to prevent the pallet from becoming heavy on one end. Doing this also helps maintain the center of balance at or near the center. Place lighter or smaller items on top of or beside the heavier cargo. Cargo with special handling labels must face outward whenever possible. Load hazardous cargo so that it is accessible to the aircrew and in such a manner to allow for ease of jettison. Construct the load in a square or pyramid shape whenever possible to make the load stable, easy to handle, and easier to secure on the pallet. Always put adequate dunnage under 463L pallets before cargo placement. The dunnage consists of a minimum of three 4- by 4- by 88-inch pieces of lumber equally spaced

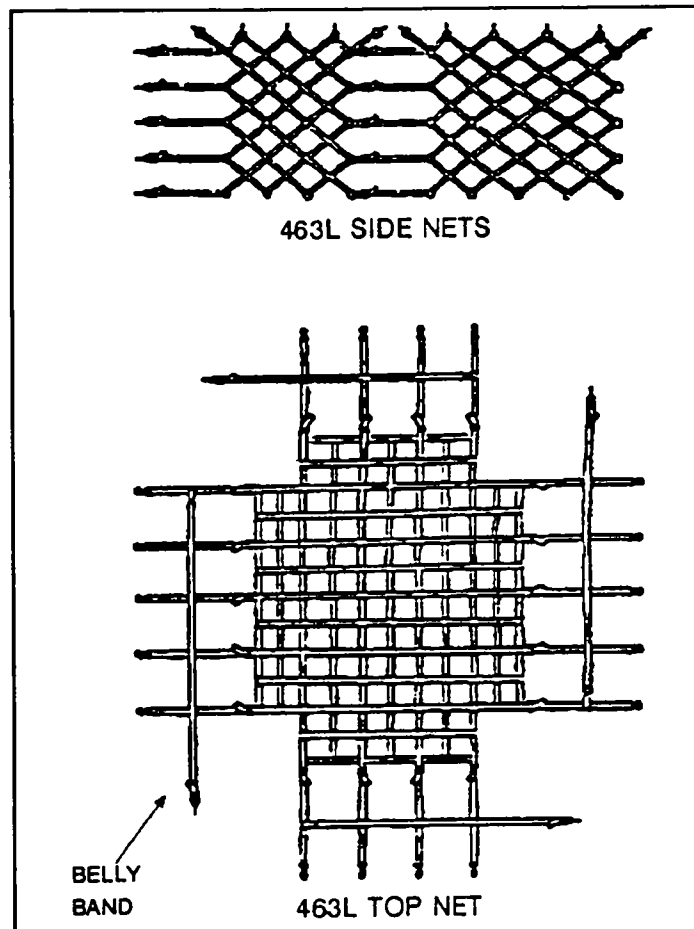


Figure D-2. 463L Pallet Nets.

under the 463L pallet. This aids the movement of the pallets by forklift and protects the lower surface from damage. Remember to ship the dunnage with the pallets for storage after unloading at the destination. Pallets that contain water-sensitive cargo, such as electronics and paperwork, or water-absorbent cargo, such as baggage, should use the plastic 463L pallet cover, NSN 3990-00-930-1480.

Unit SOPs for pallet markings may differ; however, the minimum requirement is AF Form 2279 (Figure D-4). Pallet ID cards may be obtained from your servicing TALCE. Units should produce their own marking standards for SOPs.

Each aircraft has restrictions on the dimensional size and shape particular to that aircraft. Check the specific requirements of the aircraft for which the load is prepared.

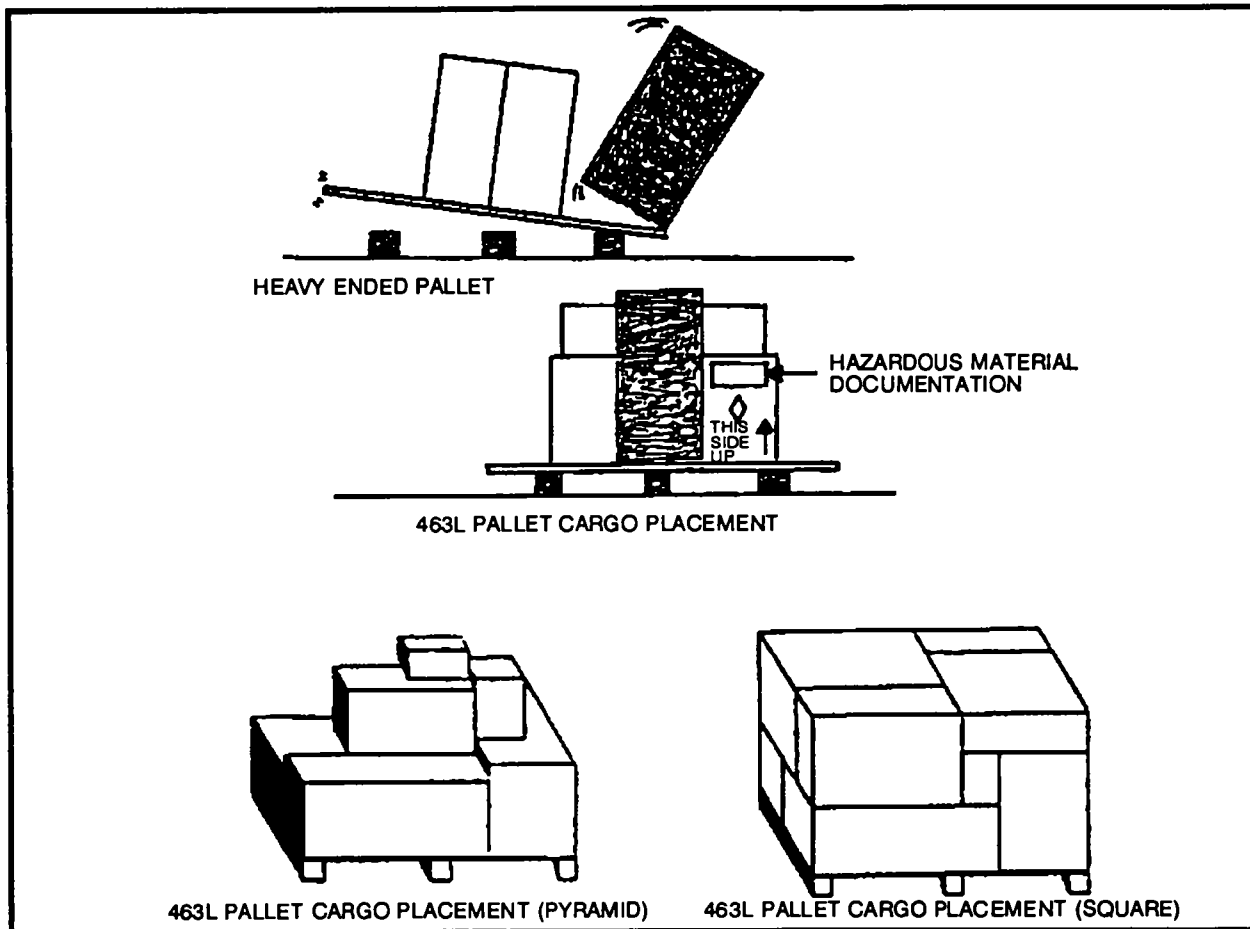


Figure D-3. 463L Pallet Cargo Placement.

PALLET IDENTIFICATION NUMBER		DESTINATION STATION	
PC-2		Pope AFB NC	
AIRCRAFT			
C141/C2M			
ORIGINATING STATION			
Langley AFB, VA			
NET WEIGHT (LBS)		GROSS WEIGHT (LBS)	
5000		5355	
MISCELLANEOUS INFO (THIS PALLET CONTAINS)		SCALE WEIGHT CERTIFICATION	
Lithium Bat		NAME (LAST)	
CARGO		DATE	
		CLOSE THIS PALLET	
AF FORM 2279 1 APR 79		PALLET IDENTIFIER	

Figure D-4. AF Form 2279.

Pallets should have pallet boards (Figure D-5) and the pallet ID cards attached. Each pallet should have two boards displayed so they are readily visible to the aircrew while in flight (normally one on the 88-inch side and one on the 108-inch side of the pallet). Using pallet boards will greatly increase the chances of misplaced pallets being returned. As a rule of thumb, the following information should be on the pallet boards:

- Packing list of containers on pallet (UMO also retains copy).
- Unit identification code and unit written out clearly.
- LOGMARS label.
- Points of contact and phone number for APOE/APOD.

CARGO NET INSTALLATION

Load and net the pallets properly to make the pallet airworthy. Prior planning is the key.

A sufficient number of personnel in the unit must be trained to do the job. The most prevalent reason cargo is bumped from an aircraft or causes delays is poor pallet buildup or netting.

Before using the nets, lay them all out and inspect them for serviceability. Do not use any nets that are torn or rotted or have loose stitching or bad or missing hooks. Only one bad strap and hook is enough to make the entire net unserviceable.

Side Nets

Identify the long sides (six hooks) and the short sides (five hooks) of the net and set the net right-side up. The net must be right-side up so the bottom hooks will point inward after the nets have been attached to the pallet rings. If the net is right-side up, the hooks face down as the net is lying on the ground. Also, many of the nets are marked OUTSIDE.

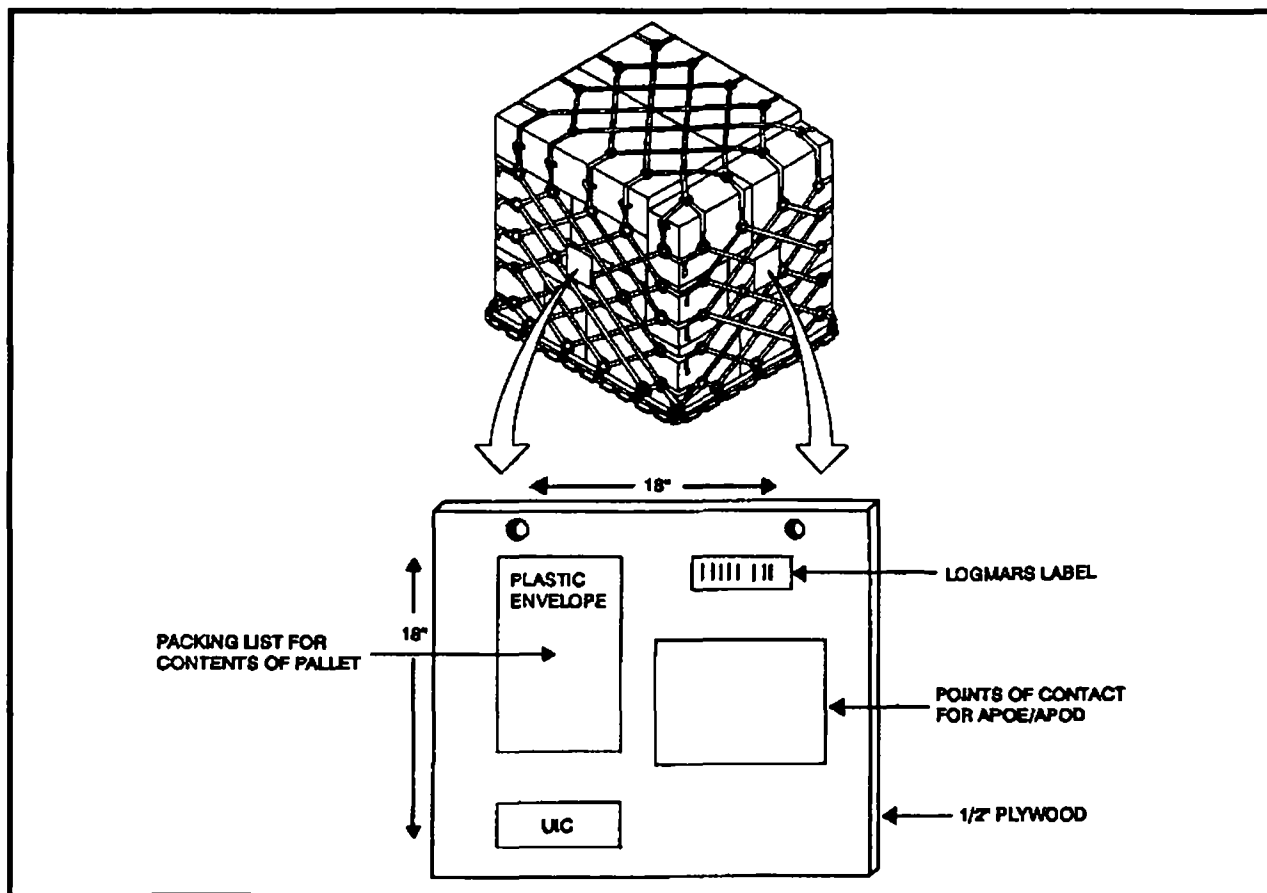


Figure D-5. Pallet Boards.

Place the two side nets around the cargo on the pallet, and hook the hooks into the pallet rings. Start at one corner and work around the pallet (Figure D-6). Make sure the straps and hooks of the net cross at the corners of the pallet. Pull the net as high as it will go and hook the two side nets together. Each side net has adjustable straps between the long and short sides to make adjustments depending on the cargo placement. Side nets correctly hooked to the pallet rings will have O rings and tension-adjustable hooks to join together, uniting the two side nets. Do not tighten these straps until the side nets are hooked to the top net.

Top Net

Center the top net over the cargo. The long side of the top net goes with the long side of the

side nets and pallet. Hook the top net into the side nets using the O rings located on the top portion of the side nets. If the cargo height restricts the use of these O rings, use the large O rings found about halfway up the side nets. Never use the bottom row of O rings with the hooks to secure the top net in place over the cargo. Cargo permitting, use the same row of rings on the side nets to ensure that the top net pulls evenly. When the top net is hooked in, two people should pull evenly on all the straps opposite of each other to tighten the top net, ensuring that the net stays equally distributed over the cargo. When all the straps are tightened, including the side net straps, tuck the loose ends of the straps into the netting to prevent snagging during loading or unloading operations.

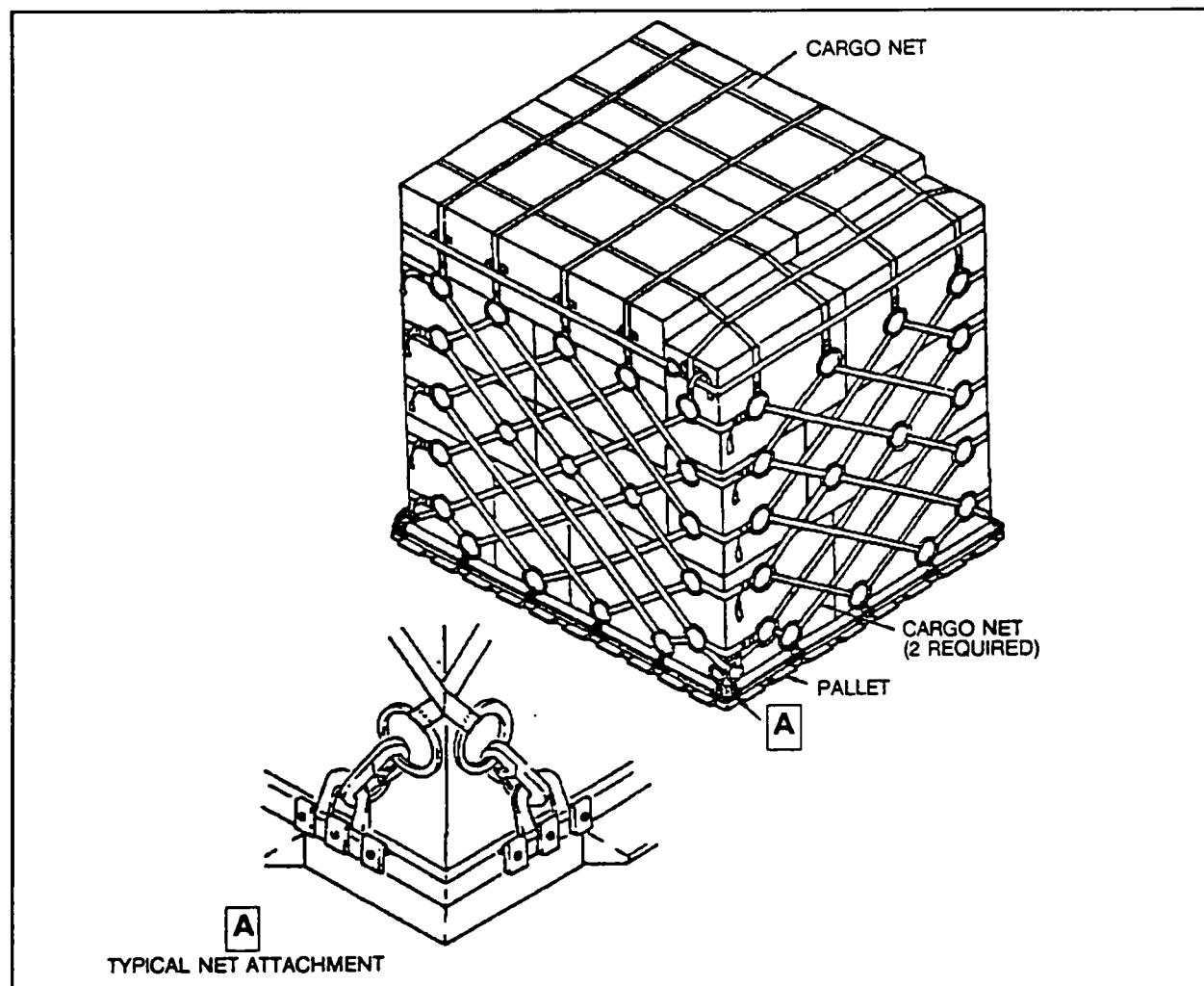


Figure D-6. Typical Net Attachment.

PALLET WEIGHT

Weigh each 463L pallet built with cargo, and record the scaled weight on all copies of the cargo manifest. Ensure the scaled weight is clearly marked on two sides (one on either 88-inch side and one on either 108-inch side) of the 463L pallet. Pallet weight markings (Figure D-7) may be stapled to the net. Measure the cargo height and record it on the cargo manifest.

NOTE: Include the weight of three-point dunnage with the pallet, as the dunnage will accompany the pallet on the aircraft.

Units should use AF Form 2279 (Figure D-4) or create their own version. It is important that the data be clearly posted and correct. As a rule, the pallet identification cards must contain the following information:

- Pallet identification number; for example, PC-2.
- Aircraft configuration; for example, C-141/C-2M.
- Originating station; for example, Langley Air Force Base, VA.
- Net weight of pallet.
- Miscellaneous information; for example, hazardous material.
- Destination station; for example, Pope Air Force Base, NC.
- Gross weight of pallet.

These pallets can be moved with a forklift, but the tines must be a minimum of 72 inches long. Use only forklifts rated at a lifting capacity equal to or greater than pallet weight. See Appendix F for guidance on MHE used in air movements.

MARRIED PALLET

*Cargo of odd shapes and sizes may require movement by air. When the requirement to ship cargo exceeds the dimensions of a single 463L pallet, join two or more 463L pallets together (Figure D-8), forming a marriage of the pallets. This is often referred to as a pallet train. It is always to

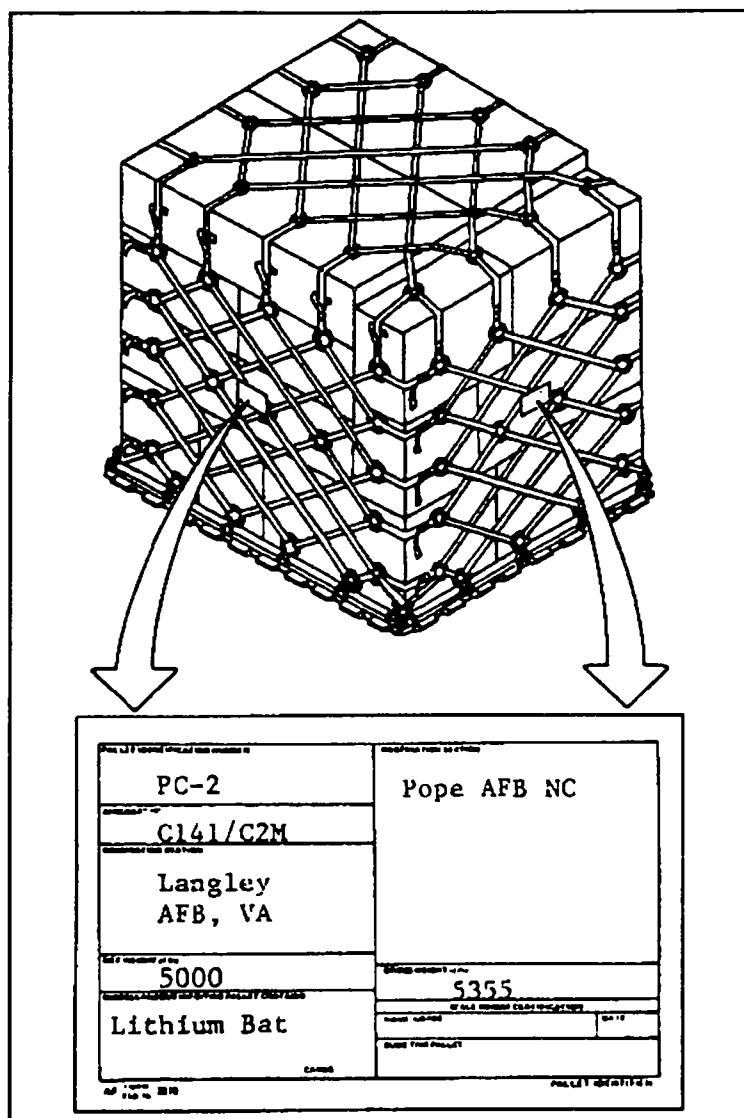


Figure D-7. 463L Pallet Weight Markings.

used to work pallet trains from an elevated platform. Place the pallets on a rollerized cargo deck, a rollerized flatbed truck, or as a last resort, a K loader (this should be avoided if possible because it will tie-up the K loader until the pallets are loaded onboard the aircraft). Align the indents of the pallet along the 108-inch side of the pallet. Space pallet couplers (Figure D-8) in the indents to lock the pallets together. Contact your affiliated ALCS for couplers.

To place cargo on married pallets, load long, heavy cargo first, distributing weight evenly over the pallet to avoid a heavy-ended

pallet. Next, place lighter or smaller cargo on top or around the heavier cargo (Figure D-9). Ensure all cargo is loaded with labels or special

handling documentation visible to load teams, air crew, and transient personnel.

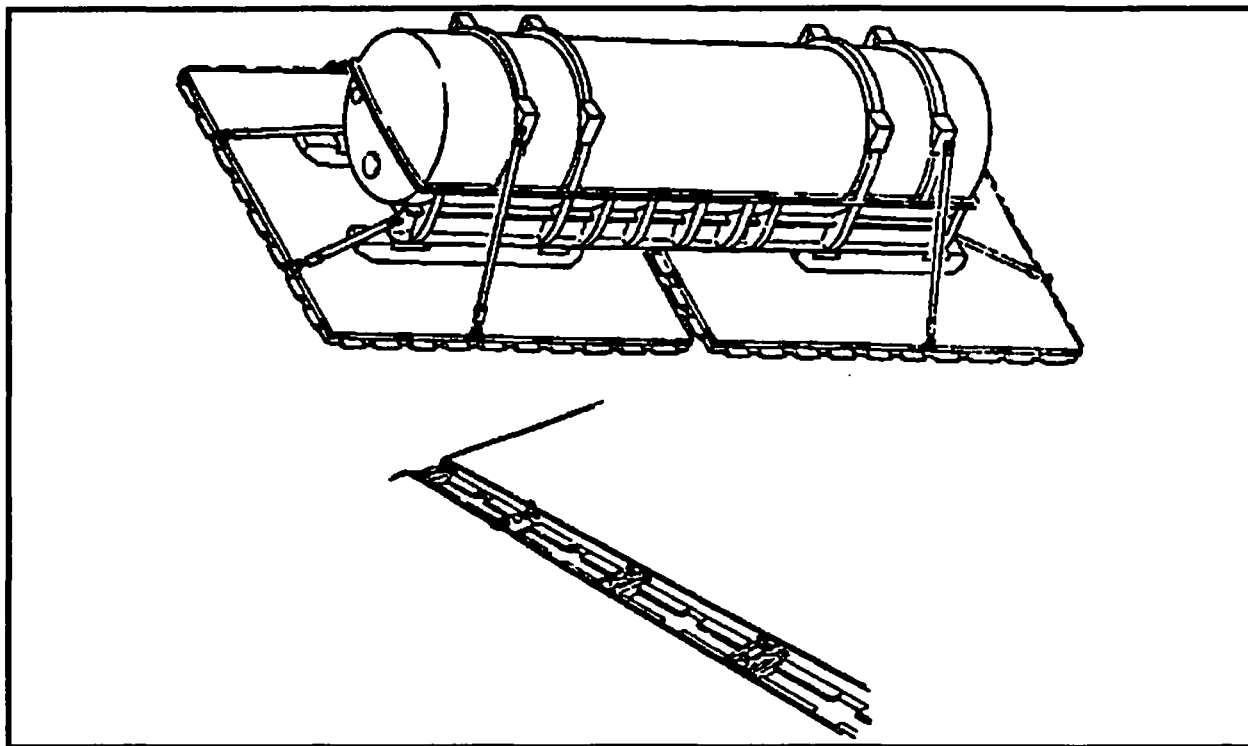


Figure D-8. Married 463L Pallet Alignment.

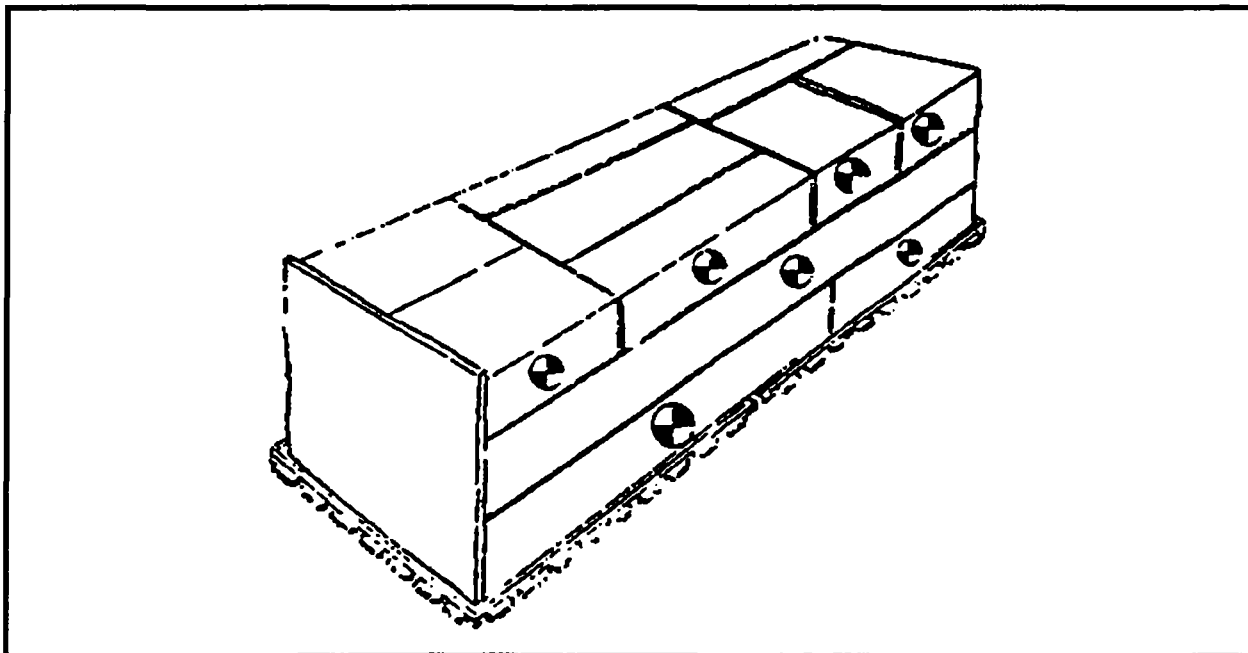


Figure D-9. Married Pallet Concentrated Cargo.

TIE-DOWN TECHNIQUES

There are many techniques for the tying down and lashing of cargo (Figure D-10). Following are some of the key points to remember:

- Use a barrier and chain gate for loose, heavy items, such as lumber and pipe.
- Use chains and tie-down devices for large items, such as canned engines or palletized wheeled items.
- Do not attach more than 50 percent of the restraint to the axles of wheeled equipment.
- Use a 463L net for multiple loose items that fit within the usable dimensions of a single 463L pallet.
- Use chains for heavy items, such as large boxes and vehicles.
- Use 5,000-pound tie-down straps, as required to provide individual item restraint or to provide supplemental restraint to 463L nets.

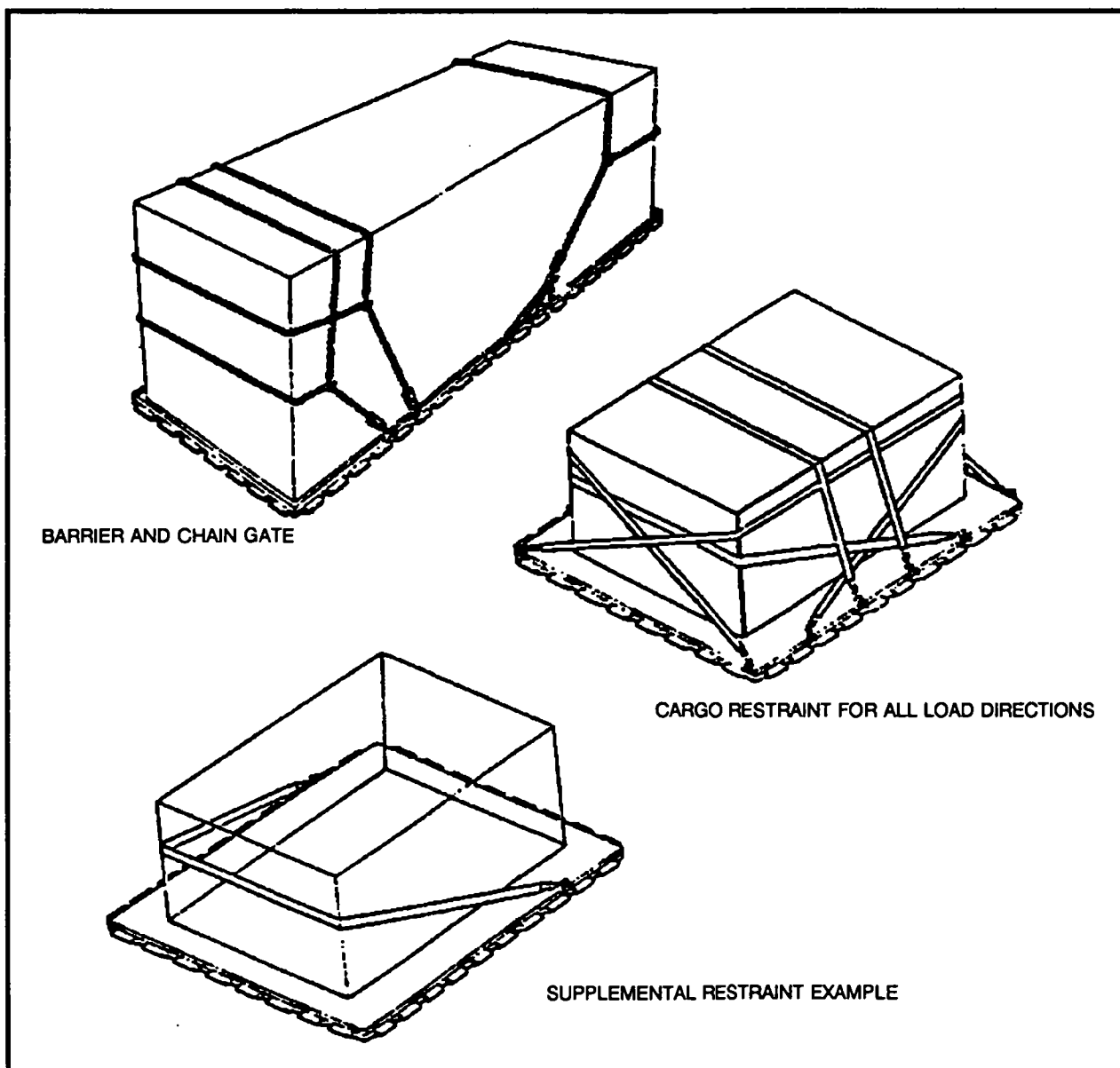


Figure D-10. Cargo Restraint.

TIE-DOWN EQUIPMENT

Table D-1 gives prices and national stock numbers (NSNs) for components of the 463L pallet

system. Units should purchase the items or draw through the local supply system adequate numbers to conduct load team training on a regular basis.

Table D-1. 463L Typical Tie-Down Equipment.

NOMENCLATURE	NSN	SIZE	COST*
Pallet, CGO Aircraft HCU-6E	1670-00-820-4896	88 x 108 x 2 1/2"	904.85
Net, CGO, Tie-Down Pallet, Top, HCU15C	1670-00-969-4103	88 x 108"	111.32
Net, CGO, Tie-Down Pallet, Side, HCU-7/E	1670-00-996-2780	88 x 108"	116.66
CGU-1/B, Nylon Strap 5,000-lb Capacity	1670-00-725-1437		12.04
MB-1, Tie-Down Chain 10,000-lb Capacity	4010-00-516-8405		9.06
MB-1, Tensioning Device 10,000-lb Capacity	1670-00-212-1149		17.59
MB-2, Tensioning Device 25,000-lb Capacity	1670-00-545-9063		400.00
Cover, Plastic Pallet 4636, HCU-6/E	3990-00-930-1480	Large, 10 per Roll	53.41
Pallet, Coupler	1670-01-856-0875	Lockheed C-130, C-141, and C-5	30.79
Pallet, Coupler	1670-01-302-3637	McDonnell-Douglas KC-10	114.00
Wheel, Load, Weigher Scale, Load, Wheel Model MD 400 Manufacturer's Code 06433	6670-00-856-0875		870.14
Kippenbrock Scale Service 9539 1st View Street PO Box 8125 Norfolk, VA 23503 PH: (804) 588-0061, Approx: 900.00			

*Costs are from FY 92 supply listing.

CHECKLIST FOR PALLET BUILDUP

The following checklist will help the unit prepare for deployment:

- ☐ 1. Are you prepared to follow good safety practices?
- ☐ 2. Do personnel have steel-toed safety shoes and work gloves, if necessary?
- ☐ 3. Have personnel been briefed on proper lifting techniques?
- ☐ 4. Is the pallet skin free of damage, top and bottom? Are there any bent lips on the 88-inch side?
- ☐ 5. Are tie-down rings serviceable?
- ☐ 6. Is the pallet level and not warped?
- ☐ 7. Is the pallet free of corrosion?
- ☐ 8. Is the pallet clean and free of dirt?
- ☐ 9. Is the pallet right side up?
- ☐ 10. Is the pallet placed on three-point dunnage?
- ☐ 11. Is the cargo to be placed on the pallet securely packaged?
- ☐ 12. Does the cargo have required markings?
- ☐ 13. Are hazardous cargo labels (SFs 400 to 422) attached to items of hazardous cargo or their containers? Is a DD Form 1387-2 (Special Handling Data/Certification) attached to all hazardous sensitive items and nonhazardous sensitive items that leave owning unit custody?
- ☐ 14. Is cargo that is marked with arrows (THIS SIDE UP) positioned with arrows up?
- ☐ 15. Are hazardous items on the pallet compatible with TM38-250?
- ☐ 16. Is all hazardous cargo positioned for easy access in flight? Are hazardous cargo labels visible from an 88-inch side of the pallet?
- ☐ 17. Is the cargo arranged on the pallet to meet the following criteria:
 - Are the heavier boxes and crates placed on the bottom of the pallet load?
 - Is lighter, more fragile cargo placed on top of the pallet load?
 - Is the cargo arranged and properly stacked so that it is stable?
- ☐ 18. Is the height of the buildup pallet 96 inches or less from the top skin of the pallet?
- ☐ 19. Is the pallet loaded with more than 10,000 pounds of cargo?
- ☐ 20. Is the cargo loaded so that it is no more than 104 inches wide with no overhang over either of the 108-inch sides?
- ☐ 21. Is the pallet loading limited to less than 250 pounds per square inch on the pallet's surface?
- ☐ 22. Is the cargo susceptible to weather damage? (If so, cover it.)
- ☐ 23. Is the cargo secured to the pallet using two side nets and a top net?
- ☐ * 24. Is the pallet smaller than 45 inches and 2,500 pounds? (If so, use a single top net.)
- ☐ 25. Does the pallet have 22 serviceable rings?

APPENDIX E

TEMPLATES

INTRODUCTION

The cargo load planning template system provides a method for load planning individual AMC aircraft. The system graphically shows the location of individual pieces of equipment within the aircraft by placing cut-out templates on the aircraft floor diagrams (DD Forms 2130-series). Figure E-1 is an example. The aircraft floor diagrams, complete with templates, are an acceptable cargo load planning and manifesting procedure for airlift operations.

The floor diagrams and template forms are created to specific tolerances and are exactly to scale when they are printed. The scale is 1/4 inch equals 3 feet. When the forms are reproduced on

a copy machine, the size of the copy will usually be slightly different from the original, which alters the scale. If a copy of a copy is made, the problem is magnified, and a load may appear to fit on an aircraft when in fact it may be too large. **Do not reproduce forms or templates.**

REQUESTS FOR FORMS

Units requiring templates should contact their post publications/forms office and submit a DA Form 17. Send the form to the Publications Stockroom, Building 208, Fort Gillem, Forest Park, GA 30050-5000.

The following is a list of existing authorized AMC forms (templates) that are available through normal channels:

AMC FORMTITLE

570	Army/Marine General Purpose Vehicles
571	Army/Marine General Purpose Vehicles
572	Army/Marine General Purpose Vehicles
573	Army/Marine General Purpose Vehicles
574	Army/Marine General Purpose Vehicles
575	Army/Marine General Purpose Vehicles
576	Army/Marine General Purpose Vehicles
577	Army/Marine General Purpose Vehicles
578	Army/Marine General Purpose Vehicles
579	Army/Marine Aviation Helicopters
580	Army/Marine Aviation Helicopters
581	Army/Marine Aviation Helicopters
582	Army/Marine Armored Truck Vehicles
583	Army/Marine Armored Vehicles
584	Army/Marine Mechanized Infantry Vehicles
585	Army/Marine Field Artillery Equipment
586	Army/Marine Air Defense Artillery Equipment
587	Army Medical Equipment
588	Army Engineering Equipment
589	Army/Marine 463L Pallets
590	Template Worksheet
591	Army/Marine Equipment
592	Army/Marine Equipment
593	Army Template Worksheet

AMC FORM

TITLE

594	Marine Aviation Equipment
595	Marine Aviation Equipme
596	Marine Equipment Worksheet
597	Marine Communication Equipment
598	Marine Communication Equipment
599	Marine Communication Equipment
600	COMNAV Spec War GRU-1
605	C-141B Configurations Worksheet
625	Naval Construction Battalion Equipment
626	Naval Construction Battalion Equipment
627	Naval Construction Battalion Equipment
630	Army/Marine General Purpose Equipment
631	Army/Marine General Purpose Equipment
632	Army/Marine General Purpose Equipment
633	Army/Marine General Purpose Equipment
634	Army Aviation Equipment
635	Army Aviation Equipment
636	Army Aviation Equipment

Figure E-1 is an example of a floor diagram using templates for cargo load planning.

Figure E-2 is an example of a unit aircraft utilization plan.

1. UNIT BEING AIRLIFTED (Name or Number) 101st ABN		2. UNIT IDENTIFICATION CODE WABHAA		3. TYPE MOVEMENT PLAN PROVIDE COMFORT/STRATEGIC		4. MOVEMENT DATE 17 DECEMBER 1992		5. UNIT AIRCRAFT LOAD NO. 1 OF 21		PAGE 1 OF 1 PAGES	
6. MISSION NUMBER		7. AIRCRAFT SERIAL NUMBER (Last Five)		8. CONFIGURATION C-2M		9. DEPARTURE AIRFIELD/ETD KADENA AB, JAPAN/1200Z		10. DESTINATION AIRFIELD/ETA CLASSIFIED/CLASSIFIED			

11. ACTUAL LOADOUT

SCALE: 1/4 INCH = 3 FEET

CODED RESTRICTIONS/LEGEND

- ○ ○ 10,000 LB TIEDOWN
- ● ● 25,000 LB TIEDOWN
- ○ ○ SEAT STANCHION
- △ ▽ VENT
- [S] [D] SINGLE/DOUBLE SEATS
- [Pattern] NO FLOOR LOADED CARGO
- [Pattern] NO AXLE LOADS
- [Pattern] NO WHEEL LOADS
- [Pattern] VEHICLE TREADWAY
- CREW REST FACILITY

LOAD SEQUENCE a.	ITEM MODEL AND NOMENCLATURE/DESCRIPTION b.	VEHICLE PACKAGE NO. OR SERIAL INCREMENT NO. c.	d. REMARKS (Special Handling, Shoring)		e. PLANNED LOAD DATA				f. ACTUAL LOAD DATA				g. REMARKS CODES (For use in Column d(1))	
			REMARKS CODE (From col g) (1)	OTHER (2)	TOTAL (In Inches)			GROSS WEIGHT (Total Pounds)	FUSELAGE STATION	MOMENT (10,000)	HEIGHT (Total Inches)	GROSS WEIGHT (Total Pounds)		FUSELAGE STATION
					LENGTH	WIDTH	HEIGHT							
1	1½ TON, TRAILER, CARGO M105A2	T-1	1A		166	83	82	4,400	470	207				1. Off center: 1A. RIGHT 1B. LEFT 2. Center line load. 3. Shoring Required: 3A. PARKING 3B. ROLLING 3C. SLEEPER 3D. SPECIAL 4. Must be positioned in direction of arrow. 5. Sequence by actual weights. 6. Hazardous Cargo: 6A. DD Form 1387-2 6B. DD Form 2133 7. Maximum fuel: 7A. 1/2 TANK 7B. 1/4 TANK 8. Equipment drained/purged: 8A. DRAINED 8B. NOT PURGED 8C. PURGED 9. Vent kit required. Other Conditions: Identify in column d(2)
2	2½ TON, TRUCK, CARGO M35A2	M-1	1A,6B 7C		265	96	89	16,700	700	1,169				
3	TRAILER, WATER M149A1	T-4	2,8A		162	82	77	2,500	900	225				
4	2½ TON, TRUCK, CARGO M35A2	M-4	2,6B 7C		265	96	89	14,200	1140	1,619				
5	463L PALLET	PC-1	2		88	108	76	5,860	1371	803				
6	463L PALLET	PC-2	2		88	108	76	2,340	1472	344				
7	TROOPS (4)							840	398	33				
12a. PASSENGER SEATS PLANNING DATA					13. TOTAL WEIGHT/MOMENT FROM REVERSE									
NUMBER SEATS	AVG WEIGHT (Pounds Each)	TOTAL PLANNED WT.												
4	210	840												
12b. PASSENGER SEATS ACTUAL DATA					14. TOTAL									
NUMBER SEATS USED	TOTAL WEIGHT (Pounds)													
15a. PLANNED LOAD DATA CERTIFICATION			DATE CERTIFIED 14 DECEMBER 1992		TYPED/PRINTED NAME, GRADE, ORGANIZATION OF PLANNING OFFICIAL THOMAS P. FLEMING, SFC, JSDTC					SIGNATURE OF PLANNING OFFICIAL <i>Thomas P. Fleming</i>				
15b. ACTUAL LOAD DATA CERTIFICATION			DATE CERTIFIED 14 DECEMBER 1992		TYPED/PRINTED NAME, GRADE, ORGANIZATION OF LOAD DATA VALIDATOR LIBBY V.D. QUINLAN, JR., MSgt, 1492 ATTF/OL A					SIGNATURE OF LOAD DATA VALIDATOR <i>Libby V.D. Quinlan</i>				

DD Form 2130-3, DEC 88

Previous editions are obsolete.

C-141B CARGO MANIFEST

* Figure E-1. DD Form 2130-3.

UNIT AIRCRAFT UTILIZATION PLAN										1. UNIT/TYPE PLAN (1) PROVIDE COMFORT				2. UIC (1) WABHAA		3. UTC (1)		4. DATE PREPARED (1) 13 DECEMBER 1992				PAGE 1 OF 2 PAGES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
5. UNIT PROJECT OFFICER (Name, grade and organization) (1) KIMBERLY R. LAMBERT, SGT, 101st ABN, FT CAMPBELL, KY 42223										6. TELEPHONE NO. (1) (502) 798-2911				7. MAC PLANNER/CERTIFYING OFFICIAL (Name, grade and organization)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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APPENDIX F

MATERIALS-HANDLING EQUIPMENT

INTRODUCTION

Materials-handling equipment includes vehicles and other devices used to aid in packaging, handling, transporting, or other manipulating of cargo in preparation for air shipment. Although there is a long list of materials-handling equipment, this chapter describes the most commonly used equipment.

MHE ACCEPTABILITY

Figure F-1 will be used to determine what type of loaders will be needed to load aircraft at the APOE/APOD.

FORKLIFTS

Forklifts are used to lift, transport, and stack cargo or equipment. Their use saves money and many man-hours of labor in handling cargo. Forklifts are located at nearly every installation in the world. Their value cannot be overstated as they will be used in almost every phase of air deployment from the construction and staging of equipment to the loading of aircraft.

RT 4000

The 4K forklift (Figure F-2) is used in warehousing, storage, and shipping operations. Within the air movements arena, it is mainly used in the construction of 463L pallets and as a pusher vehicle (loading towed loads).

RT 6000

The RT 6000 forklift (Figure F-3) can be used in many different roles, from the building of pallets to the actual loading of 463L pallets with tine extenders.

10K Forklift

The 10K forklift (Figure F-4) is the largest, most capable forklift in the airlift inventory. The 10K standard forklifts are required for moving 463L pallets that exceed 6,000 pounds.

NOTE: The movement of 10K forklifts aboard C-130/C-141 aircraft is not advised because of special loading procedures. On certain models, the rear counterweights must be removed before loading.

Tine Extenders

Tine (fork) extenders have two configurations: bare (Figure F-5) and rollerized (Figure F-6). They are used to provide additional length to forklift tines. In order for a forklift to lift or move a 463L pallet without causing damage to the pallet, the tines must be at least 72 inches long. Either type of extension is acceptable for use; however, the rollerized tines will expedite loading and unloading 463L pallets from aircraft. The tines are available through the supply system. Also, tines may be locally manufactured through most welding shops.

K LOADERS

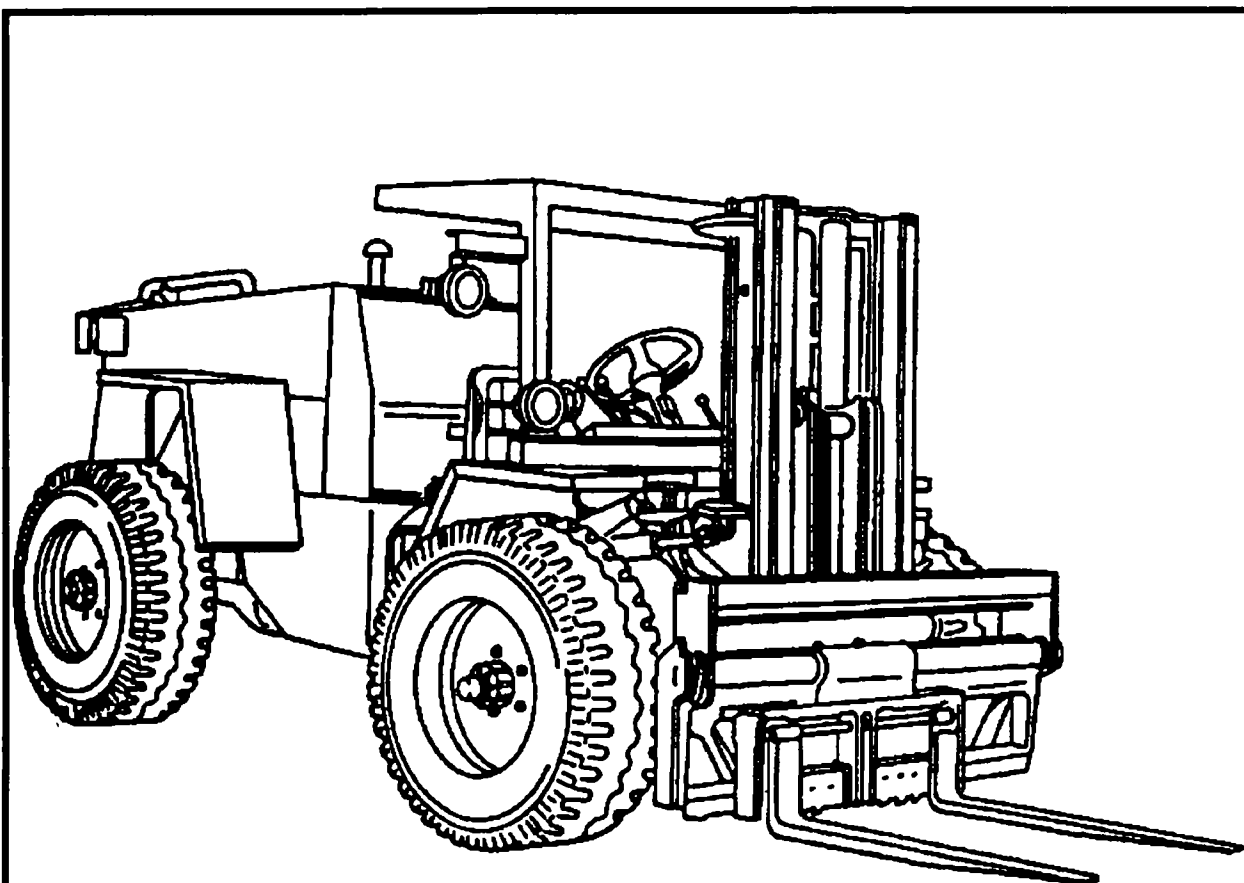
K loaders provide the capability to rapidly load and unload 463L pallets from airlift aircraft. Three types of K loaders are mainly used by moving units. Each has its own capabilities, limitations, and common features. Their quantity is limited. All are large, heavy, and difficult to transport from location to location. The K loaders will interface with, and are a part of, the 463L pallet system. They are particularly useful for handling married pallets (use rollerized trailers to build married pallets on) and airdrop platforms. Anytime K loaders are required where they are not prestaged, contact your affiliated ALCS early for coordination.

NOTE: A 60K loader is currently being field-tested that will accommodate up to six 463L cargo pallets and carry a maximum of 60,000 pounds. This K loader will also be capable of direct loading wide-body aircraft, including the KC-10, DC-10, and B-747, without the requirement for specific wide-body loaders.

Figure F-1. MHE Acceptability to Civil Aircraft.

Min-Max Height ↓			Loaders			Elevators <u>3/</u>			Forklifts					Stairs		
			40K	25K	TAC	316A	316E	CL-3	15K <u>5/</u>	10K A/T	10K STD	6K	4K	Narrow Body	C-5	Wide Body
			41"-156" <u>7/</u>	38"-156"	40"-75"	19"-217"	19"-217"	19"-222"	TO 210"	TO 80"	TO 150"	TO 150"	TO 120"	100"-160"	184"-312"	100"-200"
B 7 4 7	186"-204"	Main Deck Front/Side Door	No <u>6/</u>	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes
	108"-132"	Lower Lobes	Yes <u>1/</u>	Yes <u>1/</u>	No	No	No	No	Yes	No	Yes	Yes	M <u>4/</u>	-	-	-
D C 1 0	186"-204"	Main Deck Side Door	No <u>6/</u>	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes
	103"-119"	Lower Lobes	Yes <u>1/</u>	Yes <u>1/</u>	No	No	No	No	Yes	No	Yes	Yes	M <u>4/</u>	-	-	-
D C 8	126"-135"	Main Deck Side Door	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
	68"-100"	Lower Compartment	N/A <u>2/</u>	N/A <u>2/</u>	N/A <u>2/</u>	No	No	No	Yes	M <u>4/</u>	Yes	Yes	Yes	-	-	-
B 7 0 7	119"-126"	Main Deck Side Door	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
	54"-76"	Lower Compartment	N/A <u>2/</u>	N/A <u>2/</u>	N/A <u>2/</u>	No	No	No	Yes	M <u>4/</u>	Yes	Yes	Yes	-	-	-
L 1 0 1 1	182"-186"	Passenger Doors	-	-	-	-	-	-	-	-	-	-	-	No	Yes	Yes
	105"-112"	Lower Lobes	Yes <u>1/</u>	Yes	No	No	No	No	Yes	No	Yes	Yes	M <u>4/</u>	-	-	-
B 7 6 7	160"-176"	Passenger Doors	-	-	-	-	-	-	-	-	-	-	-	M <u>4/</u>	No	Yes
	89"-102"	Lower Compartment	Yes <u>1/</u>	Yes <u>1/</u>	M <u>4/</u>	No	No	No	Yes	No	Yes	Yes	Yes	-	-	-

- 1/ K loader must be backed up to lower lobe and may require safety rail removal to prevent contact with the aircraft fuselage. A 12-inch to 18-inch gap may exist between K loader and door.
 2/ Narrow-body aircraft would not normally need K loaders/elevator for loading of lower compartments.
 3/ Curvature of the aircraft does not permit loading of lower lobe of wide-body aircraft.
 4/ M (Marginal) - Not normally recommended for use in loading due to maximum height limits.
 5/ Should be used with rollerized pallet dolly.
 6/ With height extender adapter, the 40K loader can be used to load the main deck of wide-body aircraft.
 7/ 60 inches can be added to the height by using extender adapter.



SPECIFICATIONS

Model	Allis Chalmers
Reference	T.O. 36M2-2-140-21
Length	135 inches
Width	43 inches
Height	105 inches
Maximum Lift Height	120 inches
Tine Length	40 inches
Lift Capacity	4,000 pounds
Shipping Weight	8,365 pounds

Figure F-2. 4K Forklift.

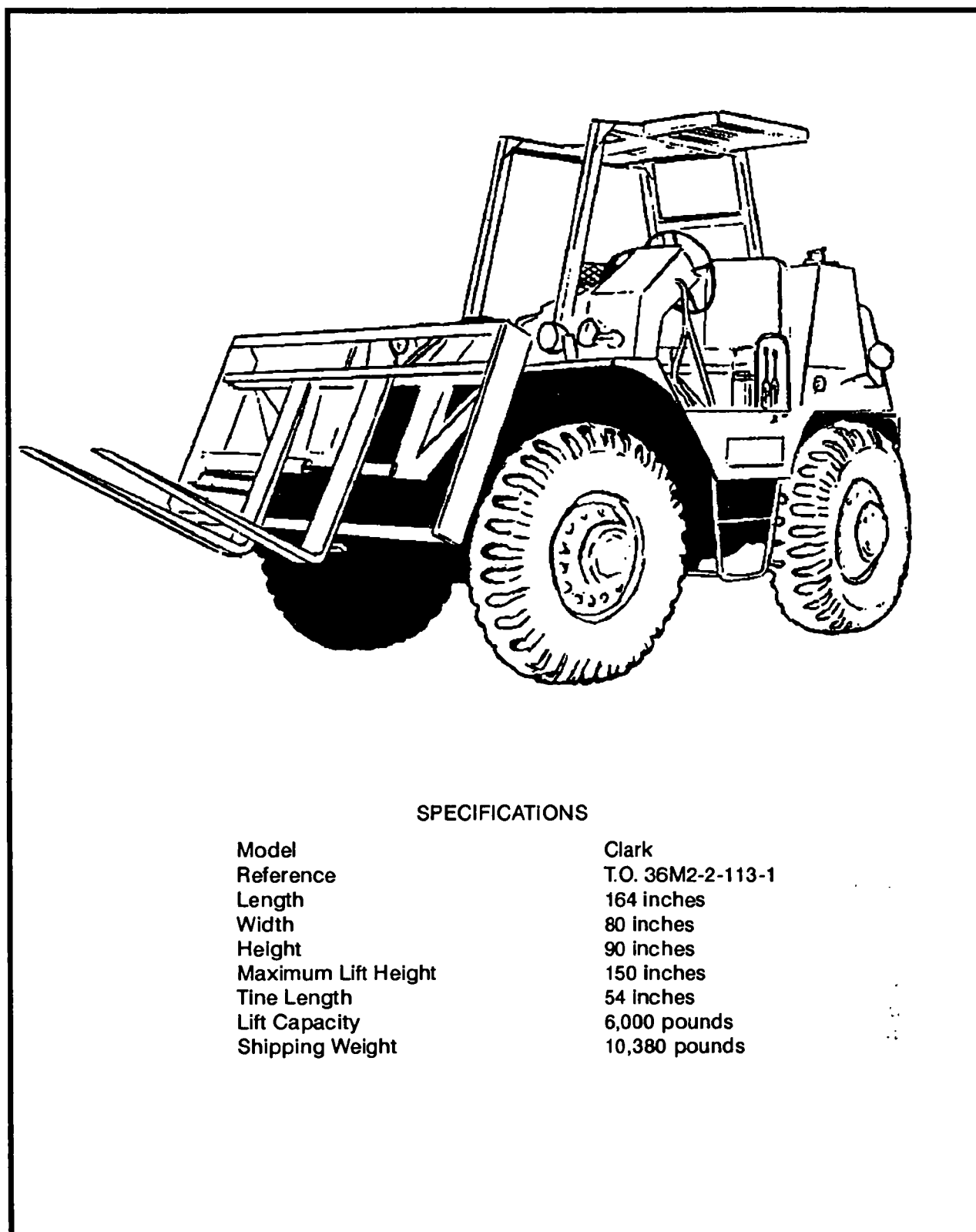
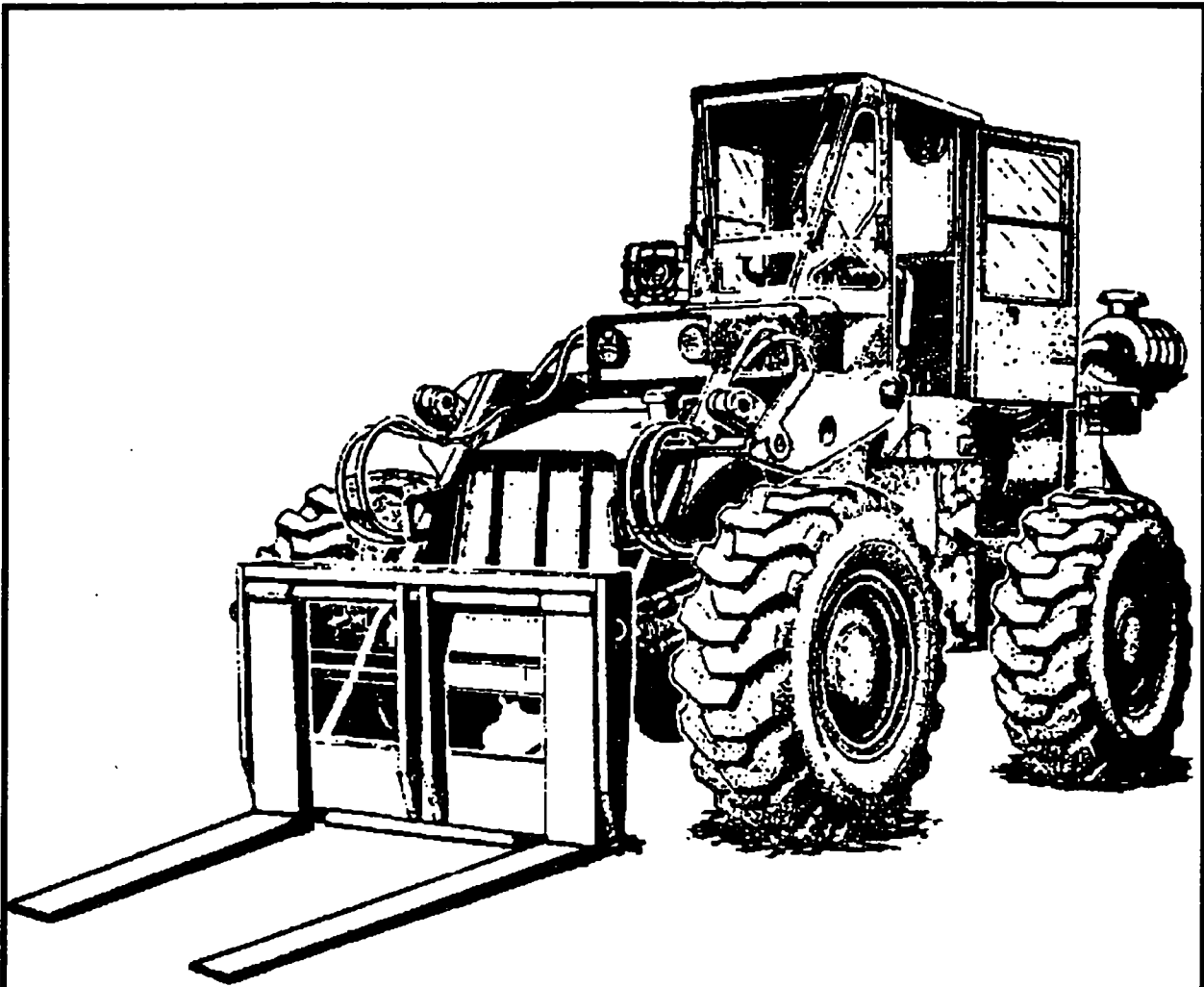


Figure F-3. 6K Forklift.



SPECIFICATIONS

Model	Allis Chalmers	Jl Case
Reference	T.O. 36M2-2-165-1	T.O. 36M2-2-159-1
Length	149 inches	312 inches
Width	75 inches	91 inches
Height	96 inches	123 inches*
Maximum Lift Height	150 inches	80 inches
Tine Length	72 inches	72 inches
Lift Capacity	10,000 pounds	10,000 pounds
Shipping Weight	22,963 pounds	22,650 pounds

*Height is reduced to 100 inches with cab removed.

Figure F-4. 10K Forklift.

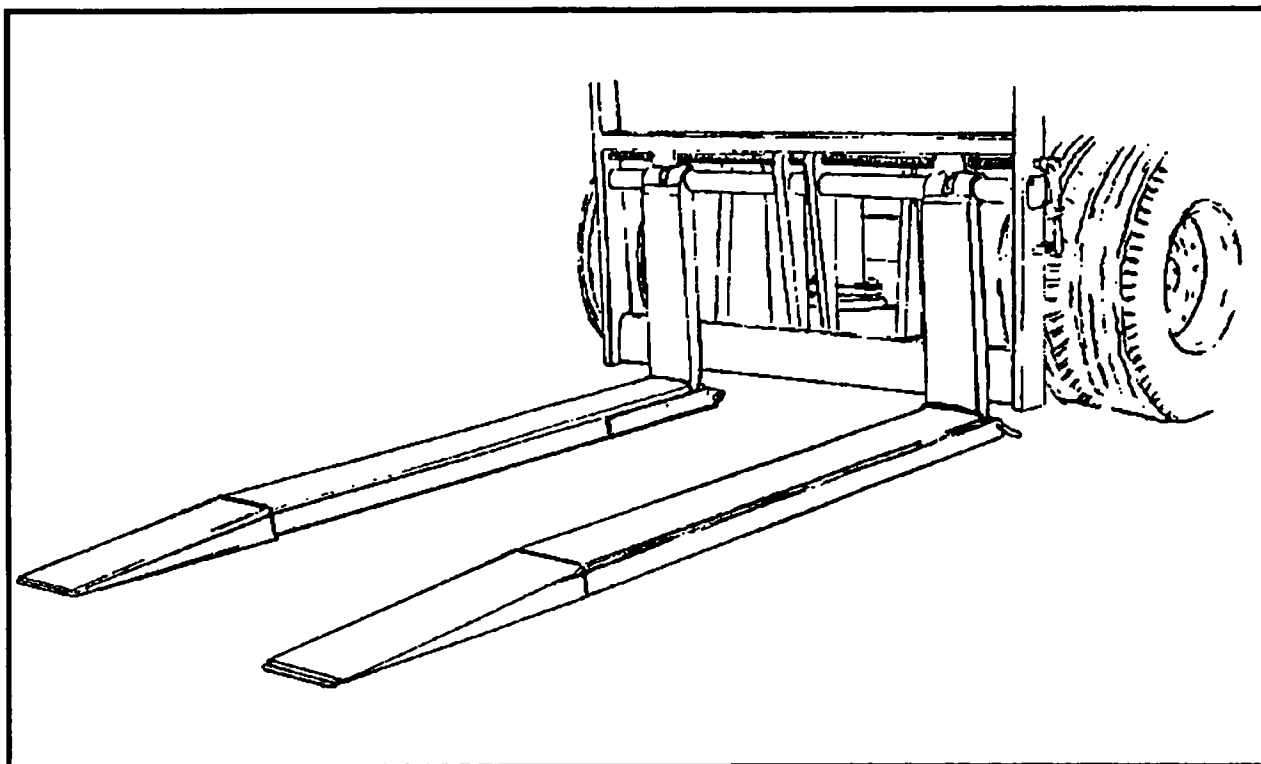


Figure F-5. Bare Tine Extenders.

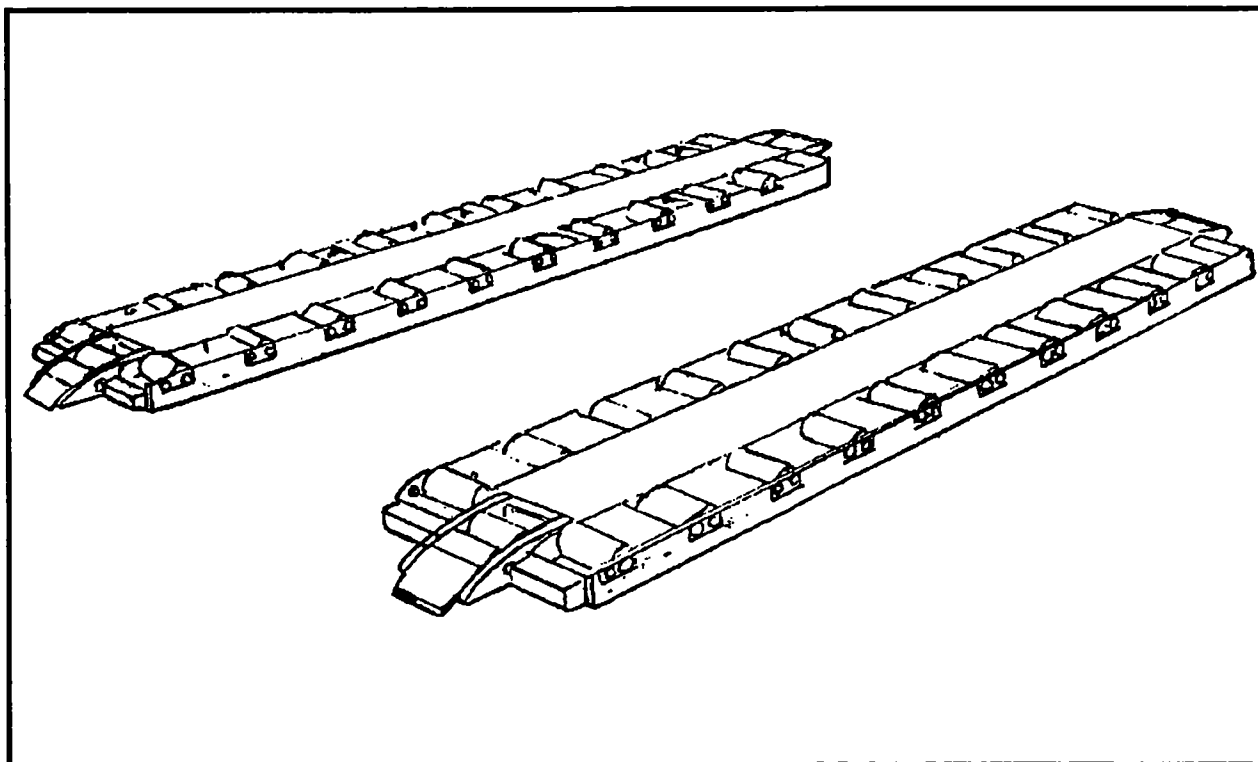
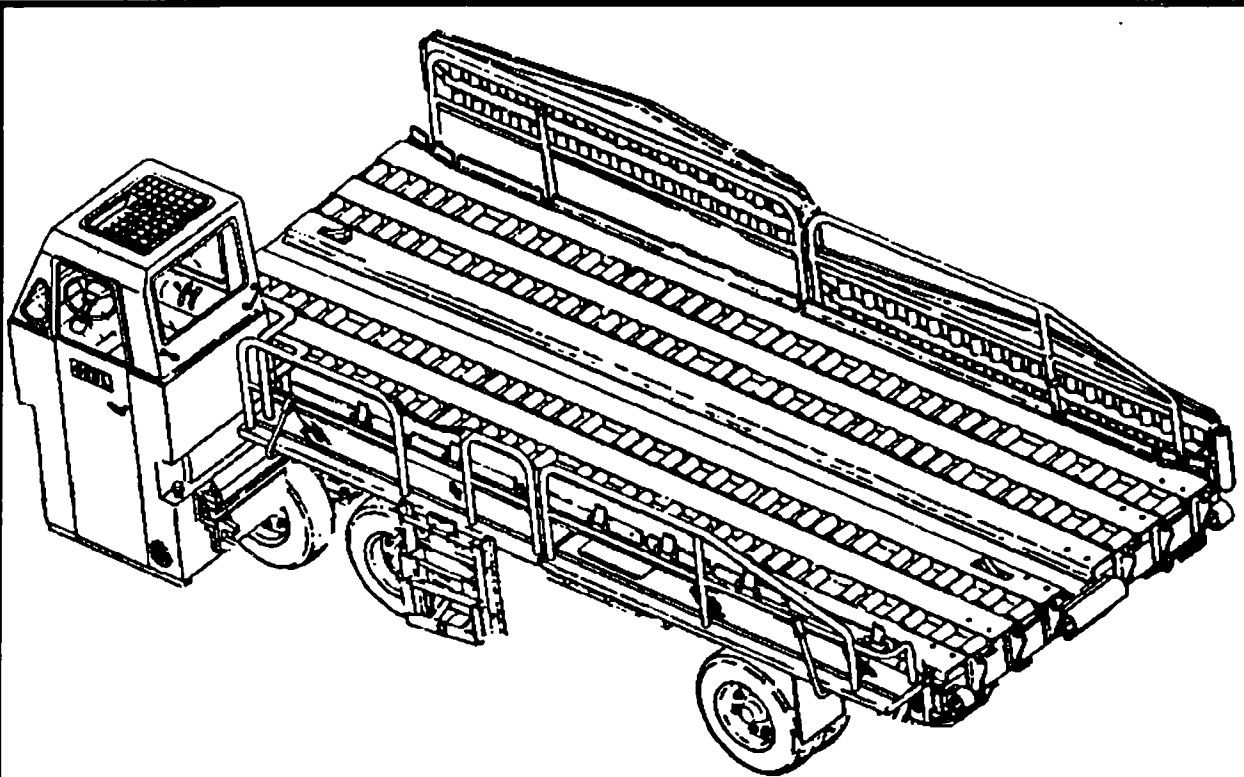


Figure F-6. Rollerized Tine Extenders.

25K Loader

The 25K loader (Figure F-7) is a self-propelled cargo transportation platform that can lift and transport three 463L pallets or 25,000 pounds of cargo. Its deck may be raised, lowered, or tilted forward or aft, permitting alignment with the aircraft floors. The deck can also roll from right to

left. The deck has rows of recessed rollers installed the entire length of the vehicle. These rollers are used as conveyers for palletized loads and may be stowed to provide a continuous, smooth surface to handle nonpalletized loads. The 25K loader is also equipped with a telescoping ladder to allow for easy access to the cargo load with the platform either lowered or fully raised.



SPECIFICATIONS

Model	CONDEC
Reference	T.O. 36M2-3-20-11
Length	327 inches
Width	
Shipping	110 inches
Operational	148 inches
Platform Height	
Minimum	38 inches
Maximum	156 inches
Pallet Capacity	3
Maximum Lift Capacity	25,000 pounds
Shipping Weight	21,485 pounds

Figure F-7. 25K Loader.

TAC Loader

The 25K TAC loader (Figure F-8) provides the same capacity as the 25K loader but also provides the capability to operate in an unpaved ramp environment. It can lift 25,000 pounds of cargo on unimproved surfaces and a maximum of 38,000 pounds on smooth, paved surfaces. The TAC loader will normally hold three 463L pallets.

It can be modified with extensions to fold five pallets (Figure F-9), but the front extension is seldom used. The TAC loader can be used to load the C-130, C-141, and C-5 aircraft. However, the C-5 must be kneeled to accommodate the TAC loader because of height restrictions. Like the 25K loader, the TAC loader is equipped with rollers and a telescoping ladder and can raise, lower, and tilt its cargo deck.

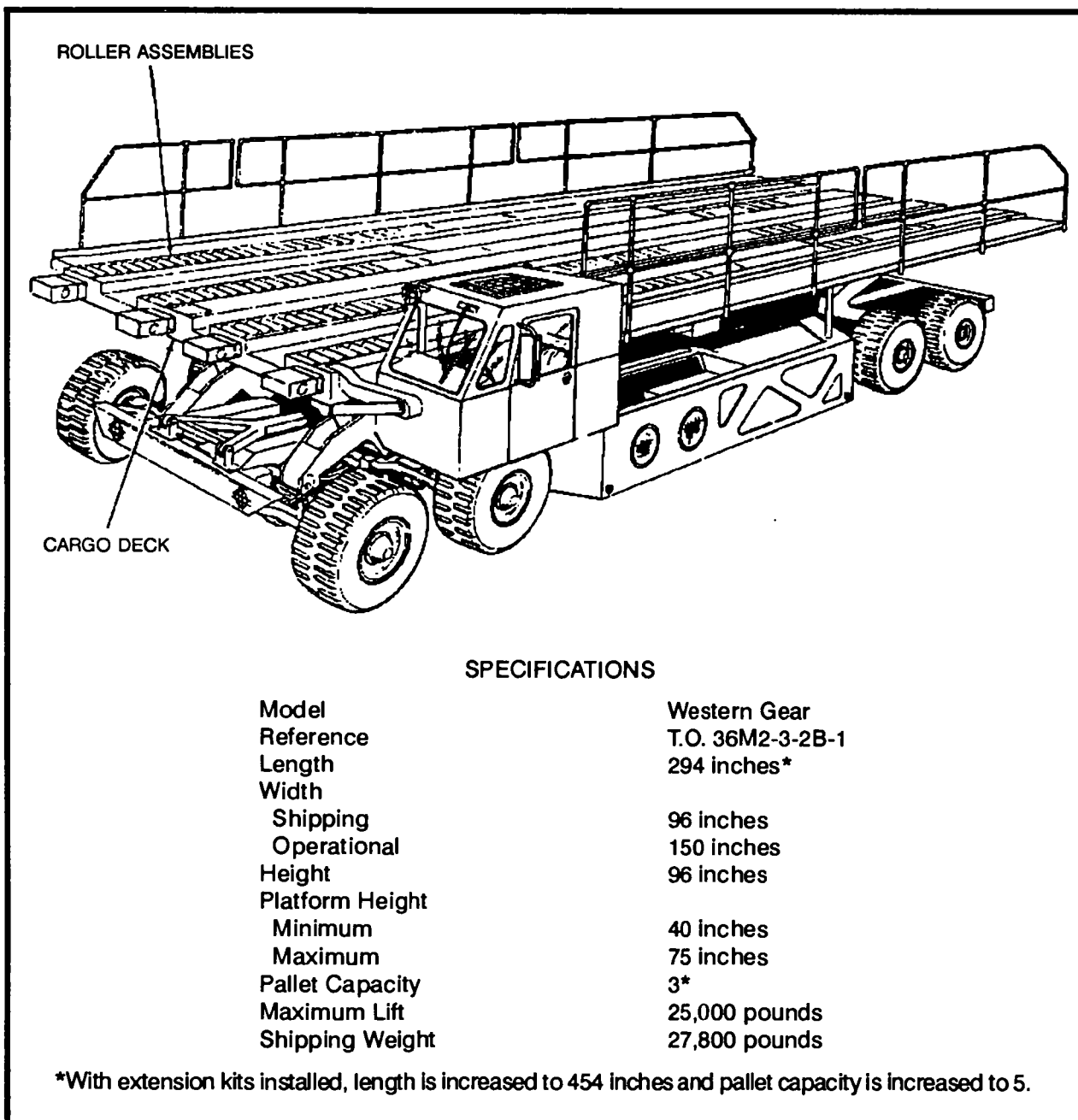


Figure F-8. TAC Loader.

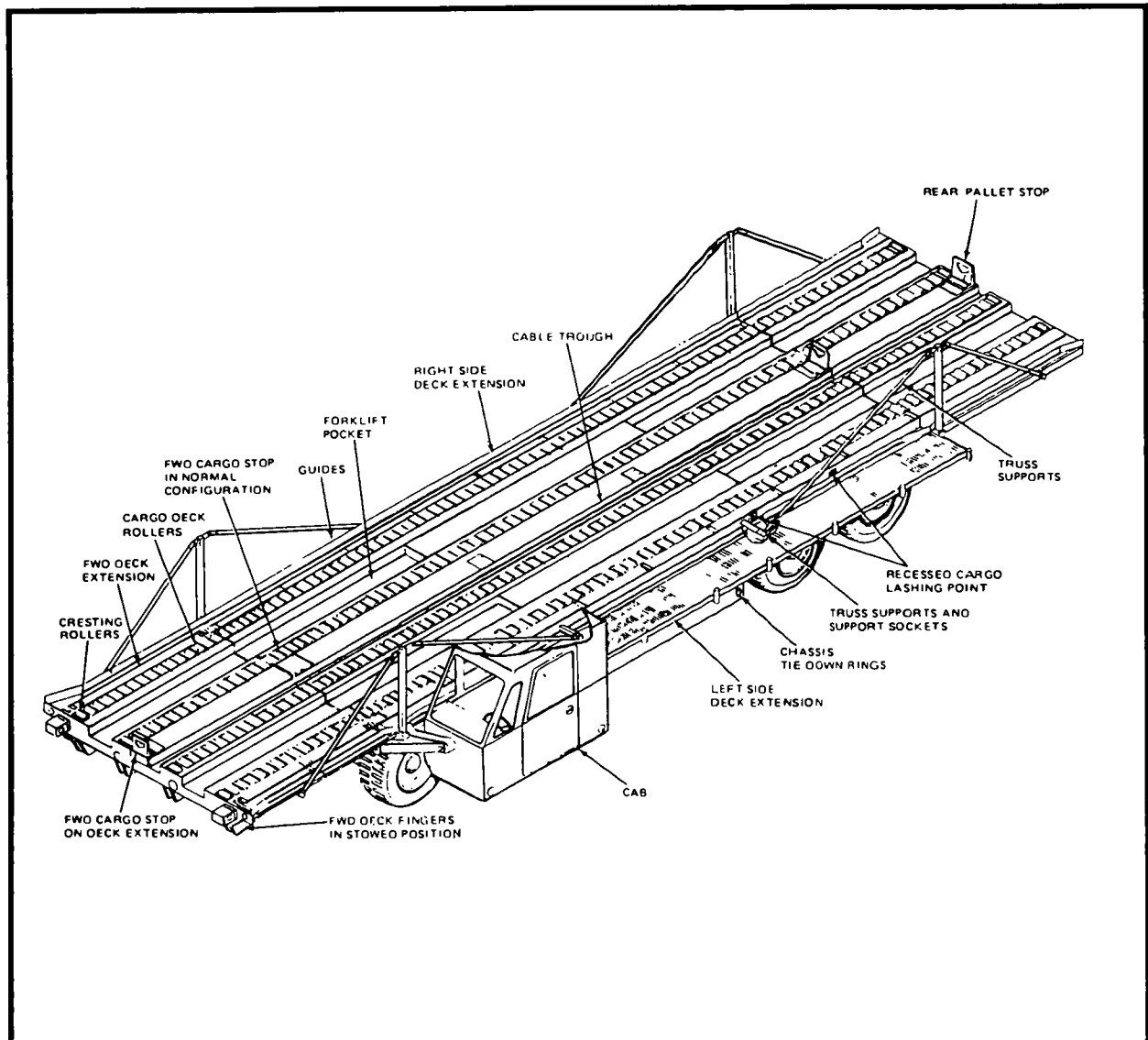
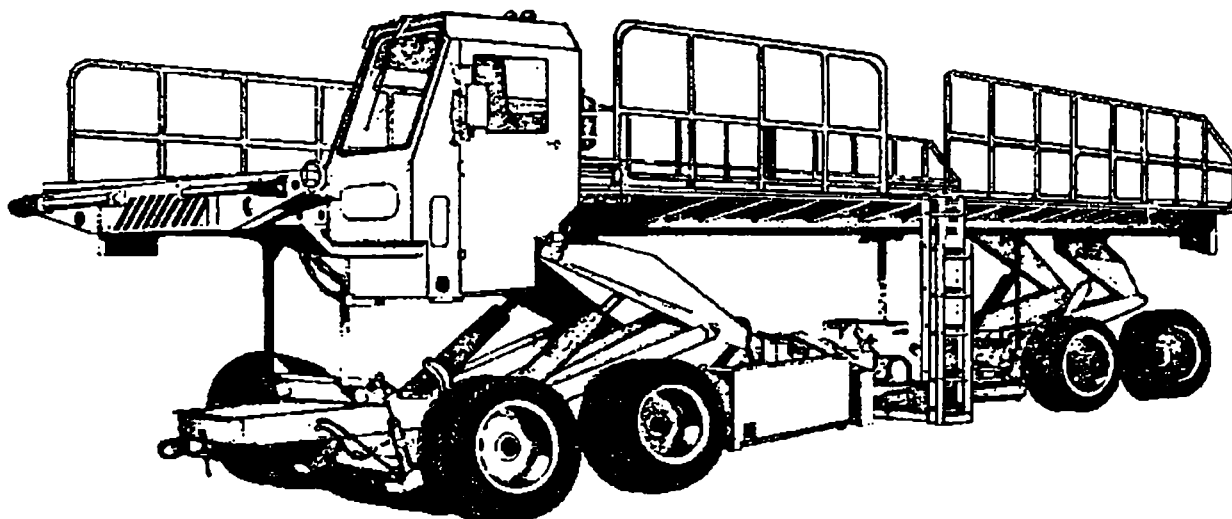


Figure F-9. TAC Loader Extension.

40K Loader

The 40K loader (Figure F-10) can lift and transport cargo loads up to 40,000 pounds, and the deck will hold five 463L pallets. The 40K deck can

raise or lower, tilt forward or aft, and roll, as well as shift right or left. The 40K loader is also equipped with removable safety rails, cat walks, ladder, and 463L system rails and locks.

**SPECIFICATIONS**

Model	Oshkosh
Reference	T.O. 36M2-3-21-61
Length	497 inches
Width	
Shipping	120 inches
Operational	155 inches
Height	81 inches
Platform Height	
Minimum	41 inches
Maximum	156 inches*
Pallet Capacity	5
Maximum Lift	40,000 pounds
Shipping Weight	49,160 pounds

*Maximum height is increased to 216 inches with 40K extender installed.

Figure F-10. 40K Loader.

40K Extender

The 40K extender (Figure F-11) is used as a primary or alternate method of loading and unloading wide-body aircraft. The extender is used as an elevator only and is not used to transport cargo. When not in use, it doubles as a highline dock. The extender is locked into the bed of the 40K loader, enabling it to reach the main deck of wide-body aircraft. It handles loaded 108- by 88-inch pallets up to a five-pallet train and can also be used to load rolling stock. The extender weighs about 10,000 pounds, thereby decreasing the capacity of the 40K by 10,000 pounds. The extender is 60 inches high and enables the 40K to reach a maximum height of 216 inches.

WIDE-BODY LOADERS

There are three primary types of wide-body loaders currently in use. Each of the loaders is air-transportable, but most must be shipped disassembled upon arrival at the APOE/APOD. Wide-body loaders cannot be used to load C-130, C-141, or C-5 aircraft because of their size and configuration. Currently, only wide-body loaders can be used to load wide-body aircraft because of the height of cargo doors. For these reasons, you must contact your affiliated ALCS if wide-body loaders will be required to ensure they arrive well before the operation commences. As a general rule, loading and unloading wide-body aircraft consumes much more time than loading and unloading AMC aircraft.

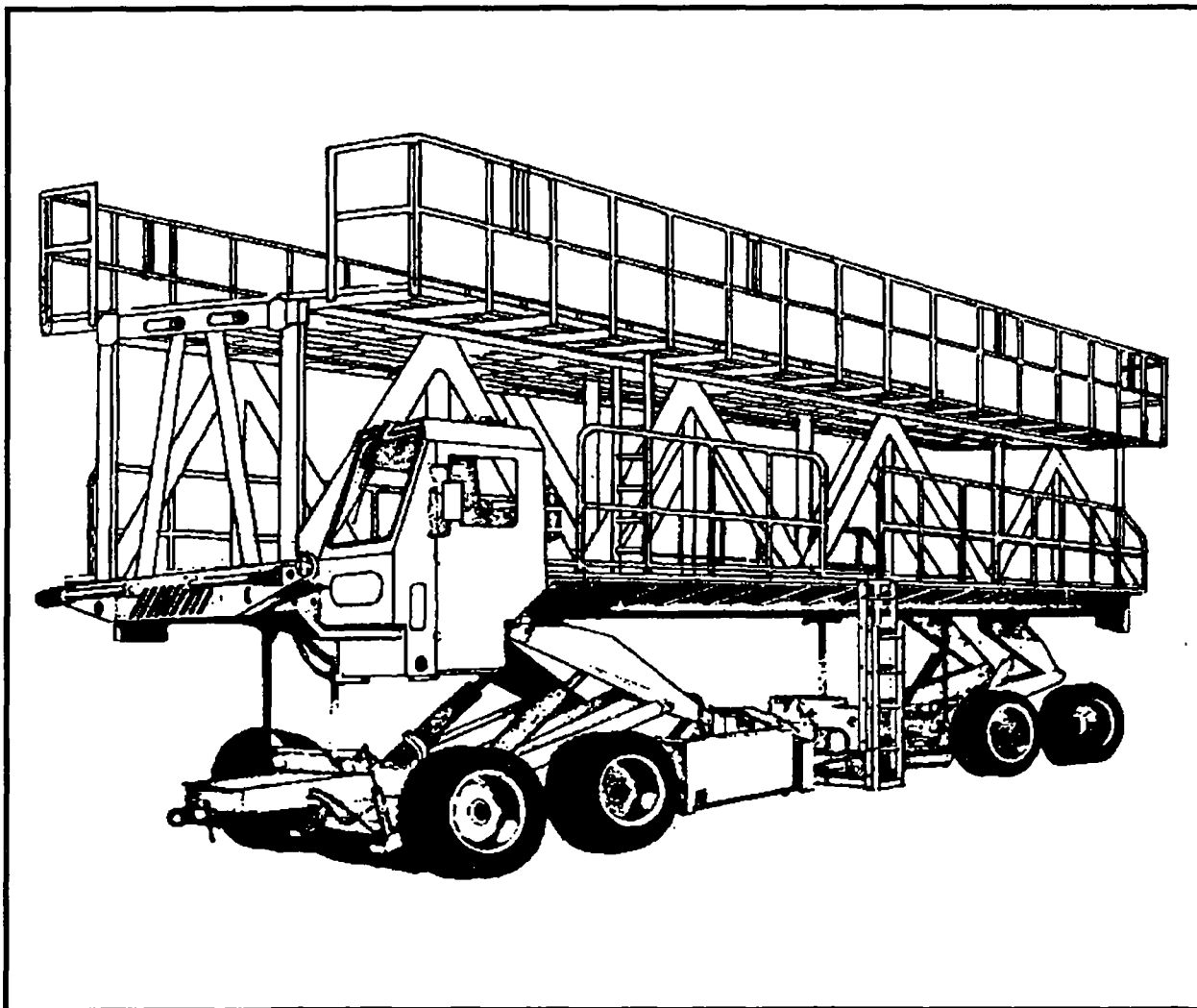
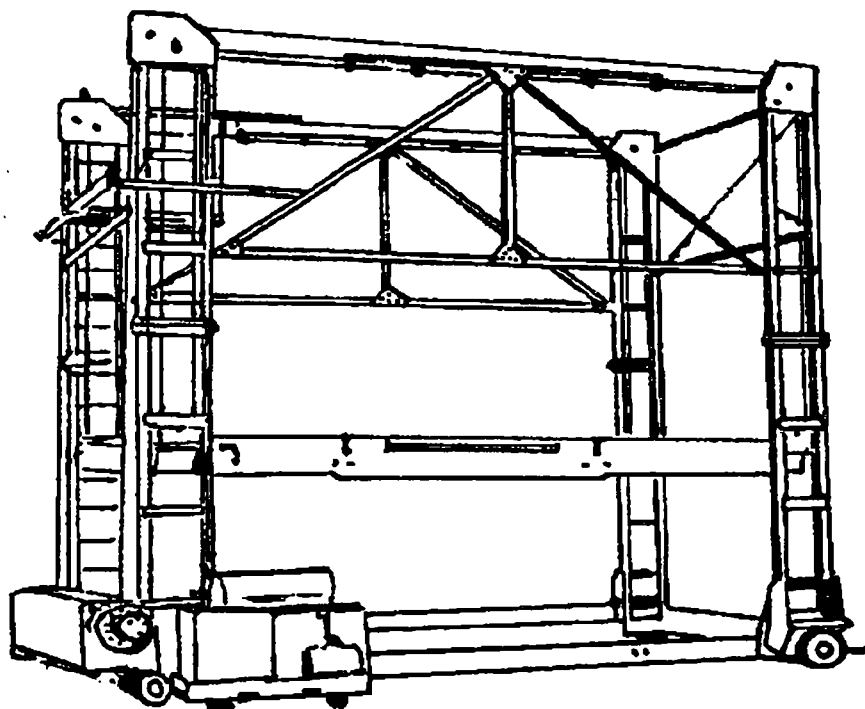


Figure F-11. 40K Loader with Extender.

316A Cochran Loader

The 316A Cochran loader (Figure F-12) is a commercially designed elevator designed to accommodate commercial-type wide-body cargo aircraft. It was the first of the wide-body loaders purchased by the military and is currently used extensively in direct support of the KC-10. The 316A can lift 25,000 pounds and will accommodate two 463L pallets. The 316A is an elevator-type

loader and will not be used to transport cargo. (The same rule applies to all wide-body loaders.) All cargo must be placed on the 316A at the aircraft and then elevated to the aircraft cargo compartment. The 316A loaders have been modified to mate with the C-141 auxiliary loading ramps for loading wheeled loads (Figure F-13). The 463L pallets must be transferred from forklifts or K loaders to the Cochran loader.



SPECIFICATIONS

Ground Movement Speed	
Low	1 mph
High	2.5 mph
Towed	5 mph
Length	288 inches
Width	183 3/4 inches
Height	252 inches
Elevator Platform	
Dimensions	128 x 252 inches
Minimum Height	19 inches
Maximum Height	217 inches
Maximum Load	25,000 pounds

Figure F-12. 316A Cochran Loader.

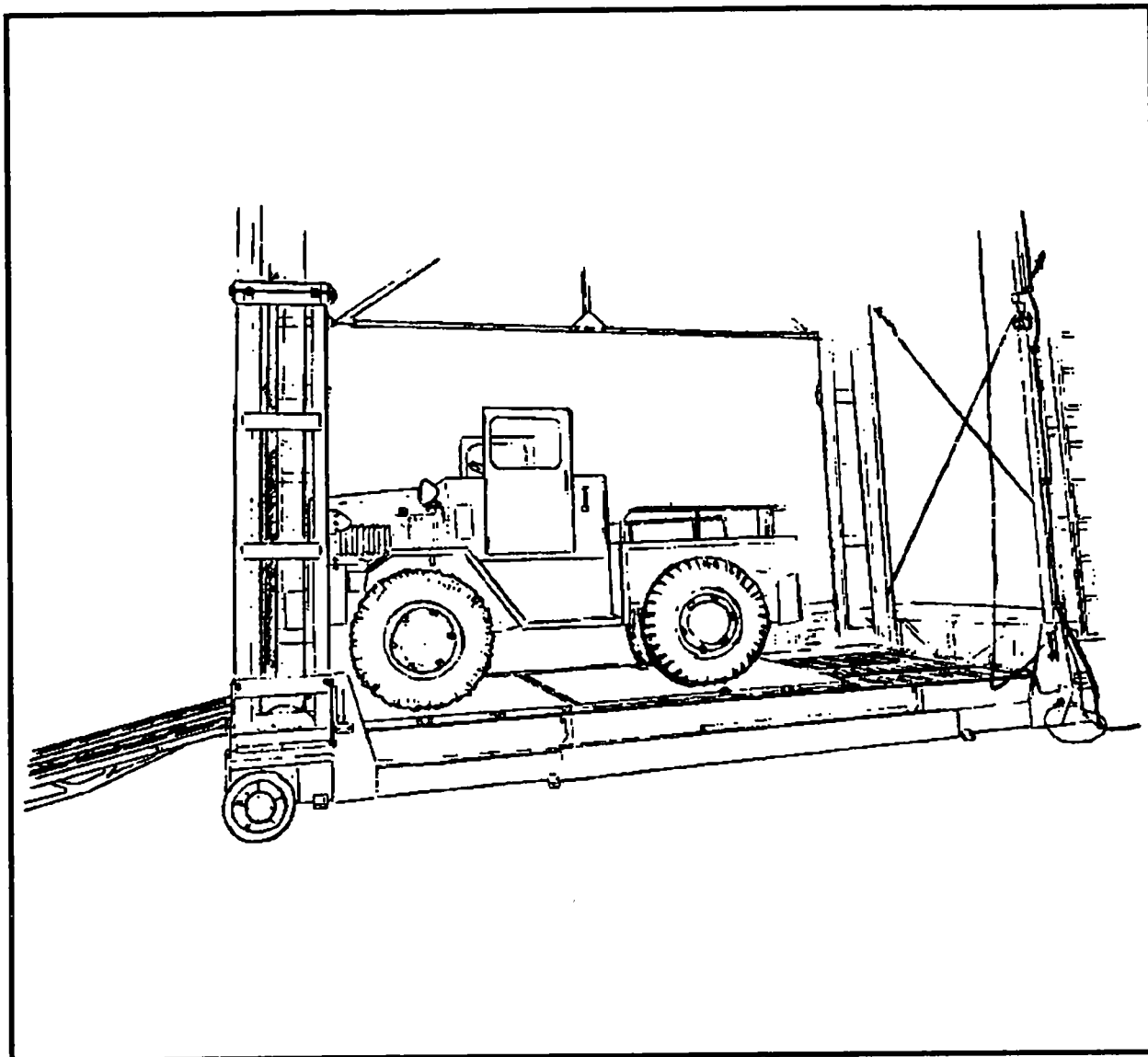
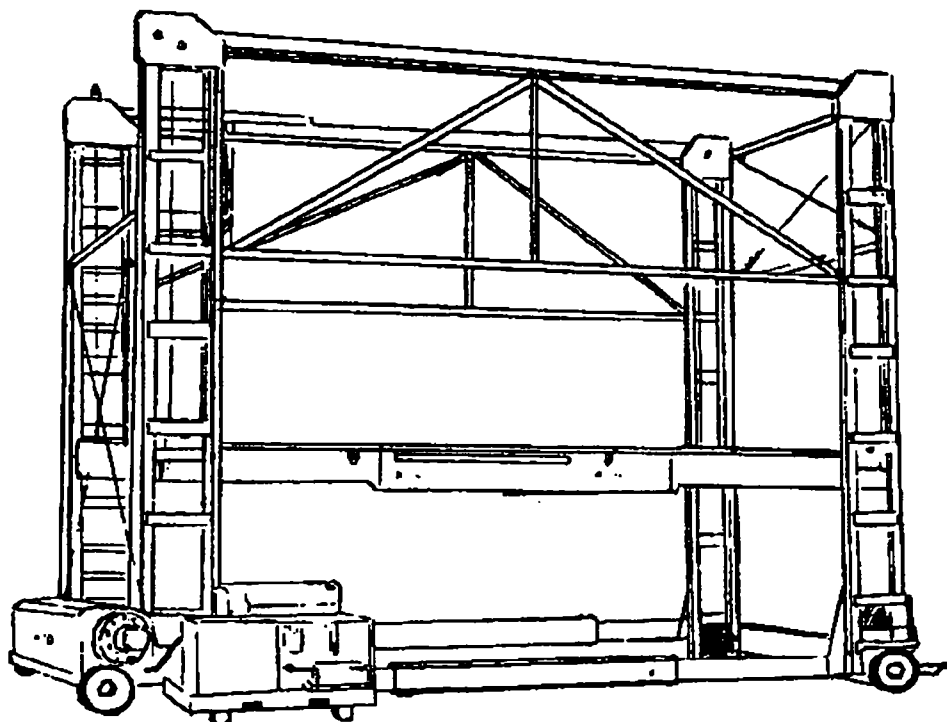


Figure F-13. 316A Cochran Loader, Loading Rolling Stock.

316E Cochran Loader

The 316E Cochran loader (Figure F-14) is an advanced version of the 316A and has increased capabilities. It is very similar in appearance and

operation to the 316A loader. The 316E loader can lift 40,000 pounds of cargo and will accommodate three 463L pallets. The 316E is the most commonly used of all the wide-body loaders and is located at most major AMC bases.

**SPECIFICATIONS**

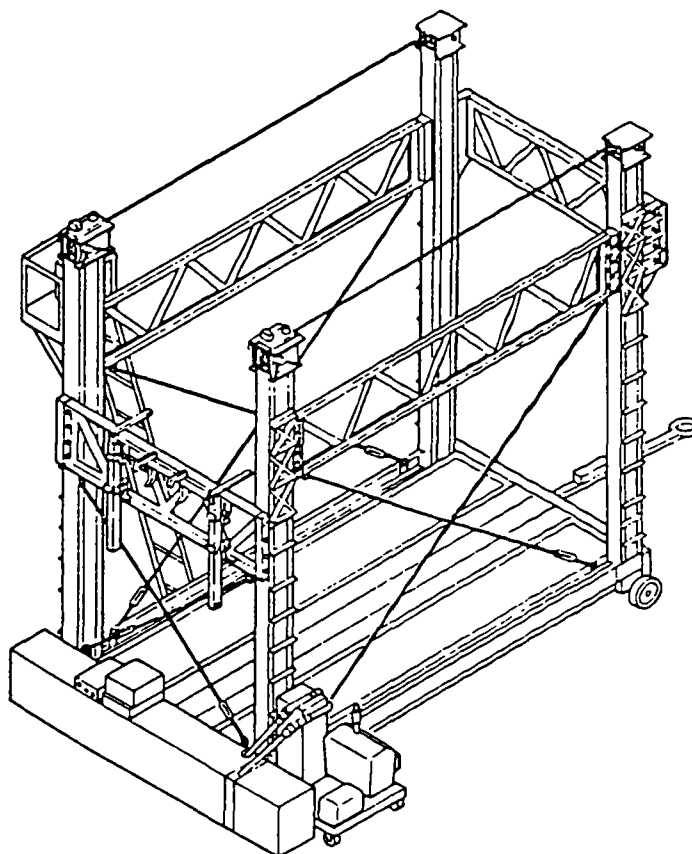
Ground Movement Speed	
Low	1 mph
High	2.5 mph
Towed	5 mph
Length	296 1/2 inches
Width	237 3/4 inches
Height	252 inches
Elevator Platform	
Dimensions	128 x 288 inches
Minimum Height	19 inches
Maximum Height	217 inches
Maximum Load	40,000 pounds

Figure F-14. 316E Cochran Loader.

CL-3 Wilson Loader

The CL-3 Wilson loader (Figure F-15) is the newest of the wide-body loaders. It was purchased to support the acquisition of the KC-10 and additional Civil Reserve Air Fleet aircraft.

NOTE: Because of the aircraft fuselage curvature, the CL-3 Wilson loader cannot be used to load wide-body lower lobes. Rollers can be turned over to permit loading of wheeled loads without the plywood subfloor.



SPECIFICATIONS

Ground Movement Speed	
Low	1 mph
High	2.5 mph
Towed	5 mph
Length	318 inches
Width	243 inches
Height	279 inches
Elevator Platform	
Dimensions	125 x 285 inches
Minimum Height	19 inches
Maximum Height	217 inches
Maximum Load	30,000 pounds

*Figure F-15. CL-3 Wilson Loader.

PUSHER VEHICLE

The pusher vehicle is a vehicle with a rated towing capacity modified by the addition of a front pintle hook (Figure F-16). These vehicles dramatically aid in loading trailers on military cargo aircraft. Pusher vehicles allow the drivers a direct view of the trailer as it moves aboard the aircraft. This is quicker and safer than having the driver rely on rearview mirrors or hand signals. Probably the

best vehicles to use as pusher vehicles are the RT 4000-series forklifts as they swivel in the middle, allowing the driver to adjust the position of the trailer without moving the pusher vehicle. Any time quantities of trailers will be moved on aircraft, you should arrange for pusher vehicles. TB 9-2300-415-40 gives specific guidance for front pintle hook construction.

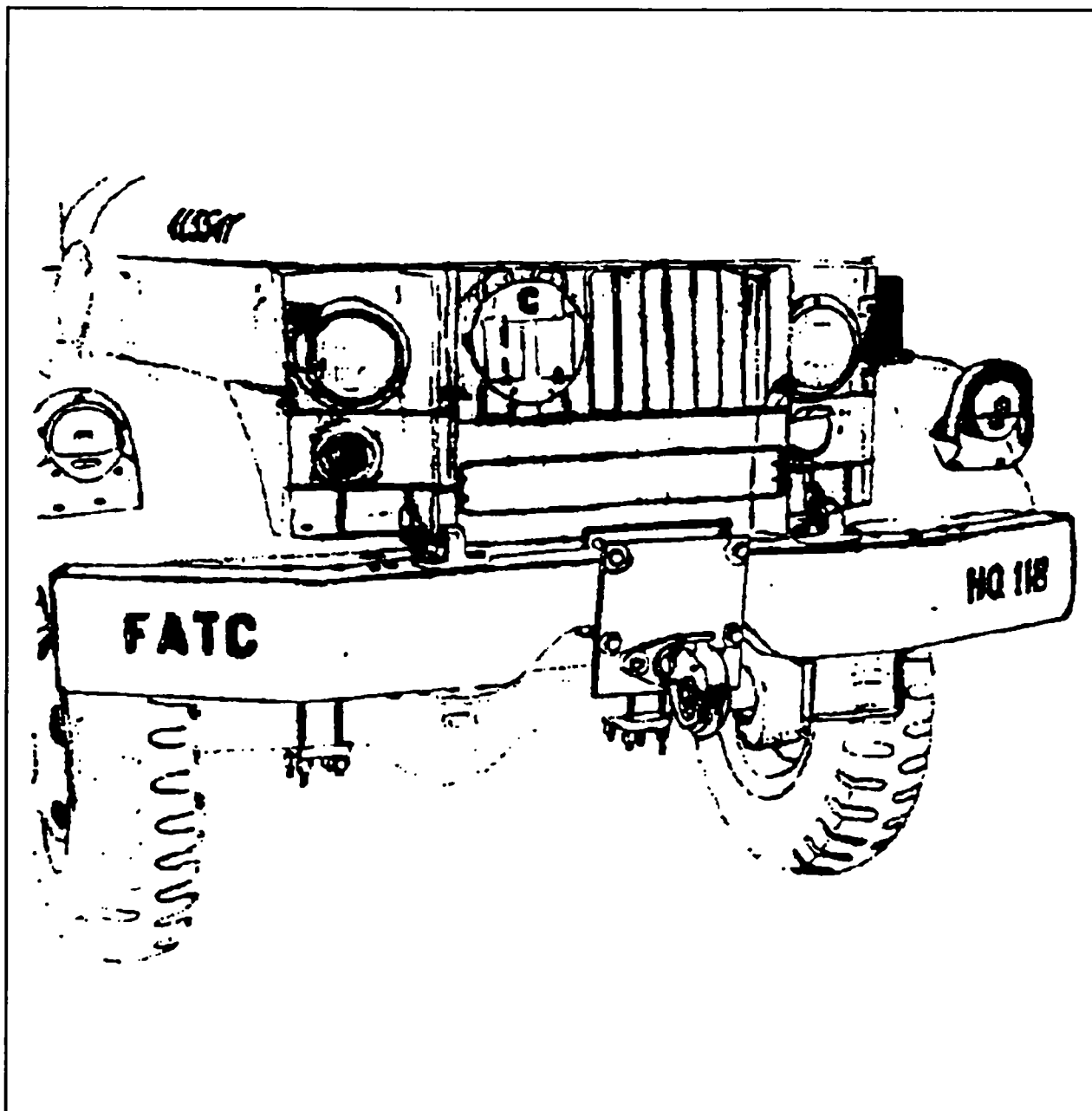
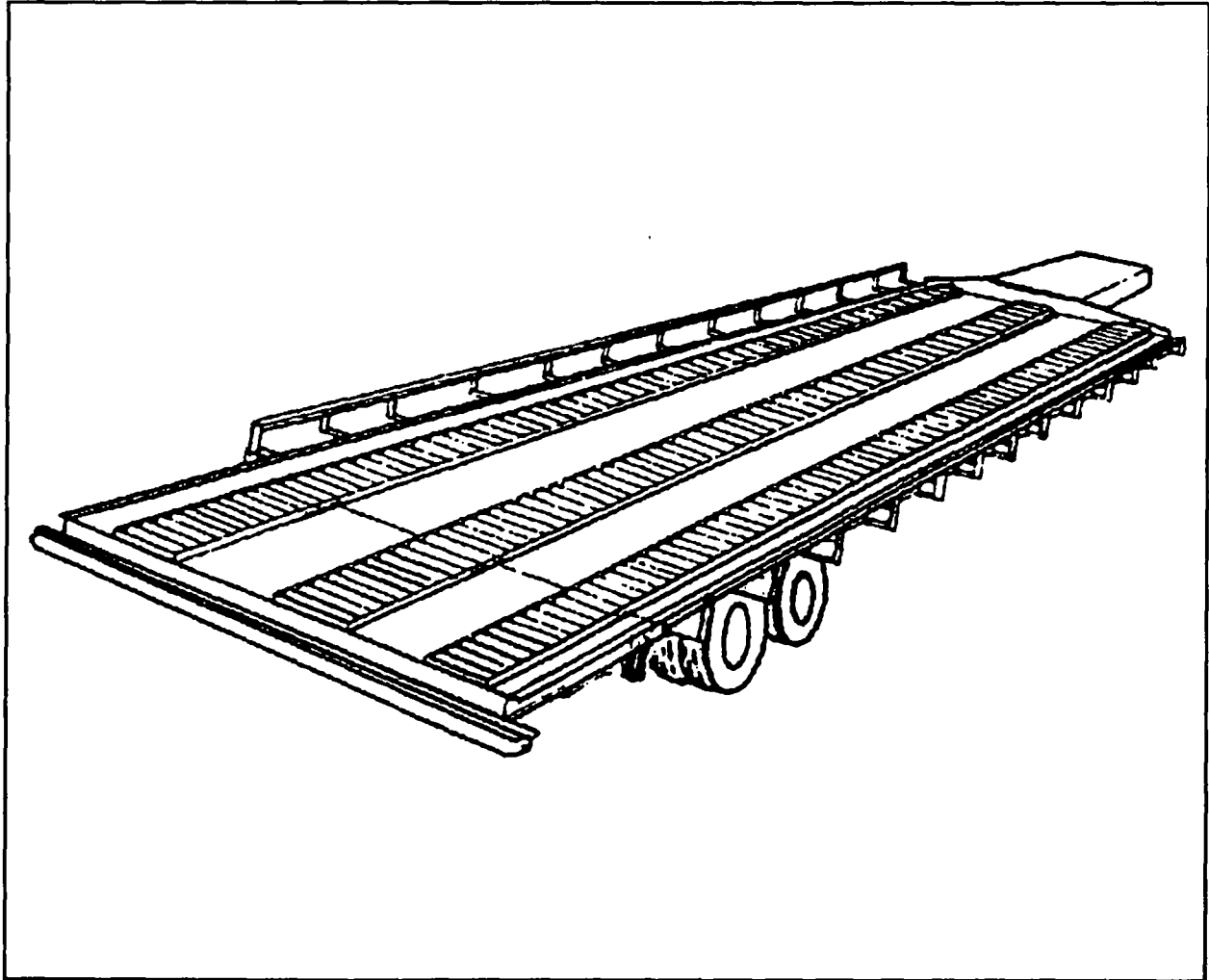


Figure F-16. Front-Mounted Pintle Hook.

ROLLERIZED FLATBED TRUCKS

Rollerized/flatbed trucks (Figure F-17) come in a variety of sizes, lengths, and load-carrying capabilities. Most flatbed trailers (not lowboys) may be modified by attaching lengths of rollers to accommodate building, transporting, storing, and loading cargo on 463L pallets. These flatbeds fa-

cilitate the speedy handling of palletized cargo, particularly when K loaders are not available. The trailers will also allow units to stage pallets in chalk order and construct married pallets without tying a K loader up with the load.



* Figure F-17. Rollerized Flatbed Truck (Typical).



GLOSSARY

***Section I. ABBREVIATIONS AND ACRONYMS**

AACG	Arrival Airfield Control Group	DSN	Defense Switched Network
AALPS	Automated Air Load Planning System	DTACC	Deployed Tanker Airfield Control Center
AC	aircraft	DTO	division transportation officer
ACL	allowable cabin load	ECP	entry control point
ADPC	Air Deployment Planning Course	EUCOM	European Command
AFM	Air Force manual	FM	field manual
AFP	Air Force pamphlet	FORSCOM	Forces Command
AFR	Air Force regulation	FS	fuselage station
AGL	above ground level	fwd	forward
ALCS	Airlift Control Squadron	g	force of gravity
AMC	Air Mobility Command	GSS	Graphics System Software
AMCP	Air Mobility Command pamphlet	GVW	gross vehicle weight
AMCR	Air Mobility Command regulation	HQ	headquarters
APO	Army post office	ID	identification
APOD	aerial port of debarkation	ITO	installation transportation office
APOE	aerial port of embarkation	JCS	Joint Chiefs of Staff
AR	Army regulation	KB	kilobytes
ATP	Allied tactical publication	LAPES	Low Altitude Parachute Extraction System
AT/RT	all terrain/rough terrain	LAT	latitude
CALM	Computer-Aided Load Manifesting System	lb	pound
CB	center of balance	LFTCPAC	Landing Force Training Command, Pacific
CCB	combined center of balance	lox	liquid oxygen
CFA	call forward area	LON	longitude
CG	center of gravity	max	maximum
CINC	commander in chief	MEE	minimum essential equipment
CONEX	container express	MHE	materials-handling equipment
CONUS	continental United States	min	minimum
CRAF	Civil Reserve Air Fleet	mph	miles per hour
DA	Department of the Army	MRE	meals ready to eat
D/AACG	Departure/Arrival Airfield Control Group	MTOE	modification table of organization and equipment
DACG	Departure Airfield Control Group	NA	not applicable
deg	degree	No.	number
DOD	Department of Defense	NSN	national stock number
		pam	pamphlet

PAX	passenger	TALCE	Tanker Airlift Control Element
pcs	pieces	TB	technical bulletin
plt	platoon	TC-ACCIS	Transportation Coordinator - Automated Command and Control Information System
PLF	pounds per linear foot	TCC	transportation component command
POM	preparation for overseas movement	TM	technical manual
PP	pallet position	TO	technical order
psi	pounds per square inch	TOE	table(s) of organization and equipment
RAM	random access memory	TRADOC	Training and Doctrine Command
RD	reference datum	UMO	unit movement officer
reg	regulation	US	United States
RL	ready line	USARPAC	United States Army, Pacific
ROPS	rollover protection system	USMC	United States Marine Corps
RT	rough terrain	USTRANSCOM	United States Transportation Command
SAAF	small austere airfield	WAM	weight, arm, moment
sec	section	WESTCOM	Western Command
SOP	standing operating procedure		
ST	short tons		
TAC loader	tactical loader		
TACC	Tanker Airlift Control Center		

Section II. DEFINITIONS

aerial port of debarkation (APOD) - A station that serves as an authorized port to process and clear aircraft (scheduled, tactical, and ferried) and traffic for entrance to the country in which located.

aerial port of embarkation (APOE) - A station that serves as an authorized port to process and clear aircraft (scheduled, tactical, and ferried) and traffic for departure from the country in which located.

aircraft commander - A pilot designated as pilot-in-command of a given aircraft. The pilot-in-command is responsible for its safe operation and is in command of all personnel on board.

air-land operation - An operation involving air movement in which personnel and supplies are air-landed at a designated destination for further deployment of units and personnel and further distribution of supplies.

Airlift Control Center - An operation center where the detailed planning, coordinating, and tasking for tactical airlift operations are accomplished. This is the focal point for communications and the source of control and direction for the tactical airlift forces.

Airlift Control Squadron (ALCS) - An in-garrison command and control unit assigned to an AMC wing and designated as a squadron. When not in a deployed posture at home station, the squadron plans for future deployments, coordinates mission support element requirements, attends joint planning conferences, coordinates and monitors joint airborne/air transportability training, and conducts AMC affiliation program training.

airlift force - Includes military strategic and tactical airlift aircraft augmented by theCRAF.

airlift mission - A mission operated to meet an airlift requirement.

Air Mobility Command (AMC) - Formerly the Military Airlift Command (MAC). A major command of the US Air Force that operates as a transportation component command (TCC) of the USTRANSCOM and provides worldwide airlift and aerial refueling support for the DOD. For purposes of this publication, the acronym AMC includes the following personnel: TALCE, aerial port, and aircrew loadmaster.

air movement - Air transport of units, personnel, supplies, and equipment, including airdrops and air-landings.

air movement plan - Plan used in detailed planning for an airlift when the airlift of troops is involved. The respective service component commanders prepare it jointly.

Air Operations Center - The Air Force operations center established by the TALCE for controlling and coordinating the airlift operations and all TALCE functions.

allowable cabin load or allowable cargo load (ACL) - The amount of cargo and passengers, determined by weight, cubic displacement, and distance to be flown, that may be transported by specified aircraft.

Arrival Airfield Control Group (AACG) - The organization that receives transported units from the Air Force carrier and controls them until released to their parent unit.

chalk - Designated troops, equipment, and/or cargo that constitute a complete aircraft load.

chalk number - The number affixed to an aircraft load to identify its sequence for loading.

Civil Reserve Air Fleet (CRAF) - Civil air carriers of US registry that contractually commit themselves to provide personnel, services, and aircraft to support AMC under stated emergency conditions.

closure time - The time the last element of a unit has arrived at a specified location.

departure airfield - An airfield on which troops and/or materiel are loaded for flight.

Departure Airfield Control Group (DACG) - The organization provided by the supported force which will control the deploying unit to be airlifted from the marshaling area until released to the TALCE at the ready line. Upon acceptance into DACG, all equipment belongs to the DACG commander until it is released to the Air Force. Functions of the DACG are the same for any service that is being airlifted.

deployment - The relocation of forces to desired areas of operation or a designated location of troops and troop units as indicated in a troop schedule.

dunnage, 463L - Any material (three each, 4- by 4- by 88-inch boards, planks, and so forth) used to support or secure pallets of the Air Force 463L materials-handling system.

estimated time of arrival - Estimated time of arrival of an aircraft over a given point or station.

estimated time of departure - Estimated time of departure of an aircraft from a given location.

global airlift - The continuous or sustained movement of units, personnel, and material in support of all DOD agencies between area commands, between CONUS and overseas, or within an area of command when directed. Strategic airlift resources possess a capability to air-land or airdrop troops, supplies, and equipment for augmentation of tactical forces when required.

gross weight - For palletized cargo, total weight of the cargo, pallet, and tie-down equipment; for unpalletized cargo, the actual (scale) weight of the cargo.

ground time - That period of time the aircraft is on the ground from arrival at the blocks (parked) to takeoff.

hazardous materials - Any material that is flammable, corrosive, oxidative, explosive, toxic, radioactive, or unduly magnetic.

joint airborne/air transportability training - An Air Force funded program that provides interservice training for the wartime application of airlift. It offers the services and AMC an opportunity to jointly develop knowledge, procedure, and proficiency for combat operations to attain and maintain wartime readiness.

load - A grouping of vehicles, equipment, and/or passengers to be loaded into a specific aircraft.

loading plan - A document that presents in detail all instructions for the arrangement of personnel and equipment aboard a given aircraft; also serves as a manifest.

loading point - A point where one aircraft can be loaded.

loading site - An area containing a number of loading points.

load manifest - A document specifying in detail the payload expressed in terms of passengers and/or freight carried in one aircraft for a specific destination.

loadmaster - The loadmaster is the Air Force representative responsible for overall supervision of loading and unloading operations of an aircraft.

load number - The symbol assigned to a specific load of cargo or passengers. The load designator remains with a specific load regardless of any substitution of aircraft. It is synonymous with chalk number.

load spreader - Material used to distribute the weight of a load over a given floor area to avoid exceeding designed stress limits.

materials-handling equipment (MHE) - Mechanical devices for handling supplies with greater ease and economy. Examples are forklifts; roller conveyors; 40K, 25K, 10K, 6K, 463L loaders; and 316A/E Cochran and CL-3 Wilson loaders.

nontactical loading - A loading process that gives priority considerations to achieving maximum use of troop and cargo space without regard to tactical considerations. Equipment and supplies must be unloaded and sorted before they can be used.

outsize cargo - Cargo that exceeds the capabilities of the C-141B aircraft and requires the use of a C-5A/B. Consult TO 1C-141B-9 for the aircraft to determine if the item can be transported on the C-141B aircraft.

oversize cargo - Any single item that exceeds any one of the following dimensions: 104 inches long, 84 inches wide, and 96 inches high. It will not fit on a 463L pallet. For broad planning purposes, a 463L pallet loaded to a maximum height of 48 inches will fit all main deck-loaded CRAF cargo aircraft. However, height increases are possible by contouring to the cargo envelope dimensions of that particular aircraft.

pallet, 463L - A flat base (platform) used for combining cargo, equipment, or a single load item to facilitate the storing, handling, and air transporting of these items with the Air Force 463L materials-handling system.

parent organization (unit) - 1. Table of organization and equipment (TOE) units, regardless of size, that have a numerical designation and unit identification code assigned by DA. 2. Table of distribution and allowance (TDA) units that have a specific descriptive designation and approved unit identification code assigned by DA. 3. An organization (unit) responsible for furnishing all or a portion of the common support requirements of another installation or separate organization.

parent station - An organization (installation) designed to furnish all or a portion of the common support requirements of another installation or separate organization.

planeload/troop commander - designated officer or noncommissioned officer responsible for the aircraft load (equipment, supplies, and/or personnel) which he accompanies.

pusher vehicle - Any self-propelled vehicle, such as a 1 1/4- or 2 1/2-ton truck, with a front bumper-mounted pintle hook. This vehicle is used to push disabled vehicles, trailers, howitzers, aircraft engines, and so forth, aboard aircraft, and it provides load team transportation.

rolling stock - Powered or nonpowered wheeled equipment.

special assignment airlift mission - Airlift requirements that involve special consideration because of the number of passengers involved, weight or size of cargo, urgency of movement, sensitivity, or other factors that preclude the use of a channel (scheduled) airlift.

supported service - The military service or agency whose traffic is being moved.

tactical loading - The arrangement of personnel and the storage of equipment and supplies in a manner designed to conform to the anticipated tactical operation of the organization embarked. Each individual item is stowed so that it can be unloaded at the required time.

Tanker Airlift Control Element (TALCE) - A deployed element of an ALCS. The TALCE is a composite organization tailored to support airlift missions transiting locations where command and control, mission reporting, or support functions, as required, are nonexistent or require augmentation.

theater airlift - Airlift that provides the immediate and responsive air movement and delivery of combat troops and supplies directly into objective areas through air-landing, extraction, airdrop, and other air delivery techniques. It provides air logistic support of all theater forces, including those engaged in combat operations, to meet specific theater objectives and requirements.

unit loading - The loading of troop units with their equipment and supplies in the same ship, aircraft, or land vehicle.



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FM 55-9
5 APRIL 1993

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GORDON R. SULLIVAN
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Official:

Milton H. Hamilton
MILTON H. HAMILTON
Administrative Assistant to the
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FM 55-9

- Must not allow trash or debris to be thrown on the flight line. Personnel must also ensure that canvas or small pieces of equipment are secure to prevent the jet exhaust from blowing them around.
- Must not stand or walk directly in front of or behind vehicles being driven or backed into the aircraft.
- Must not back vehicles toward or into an aircraft without spotters placed at the front and rear corners of the vehicle. (The aircraft loadmaster directs all backing.) Spotters should not be directly in front of or behind any moving vehicle.
- Must not stand between a moving vehicle and any stationary object, such as another vehicle, aircraft, or buildings.

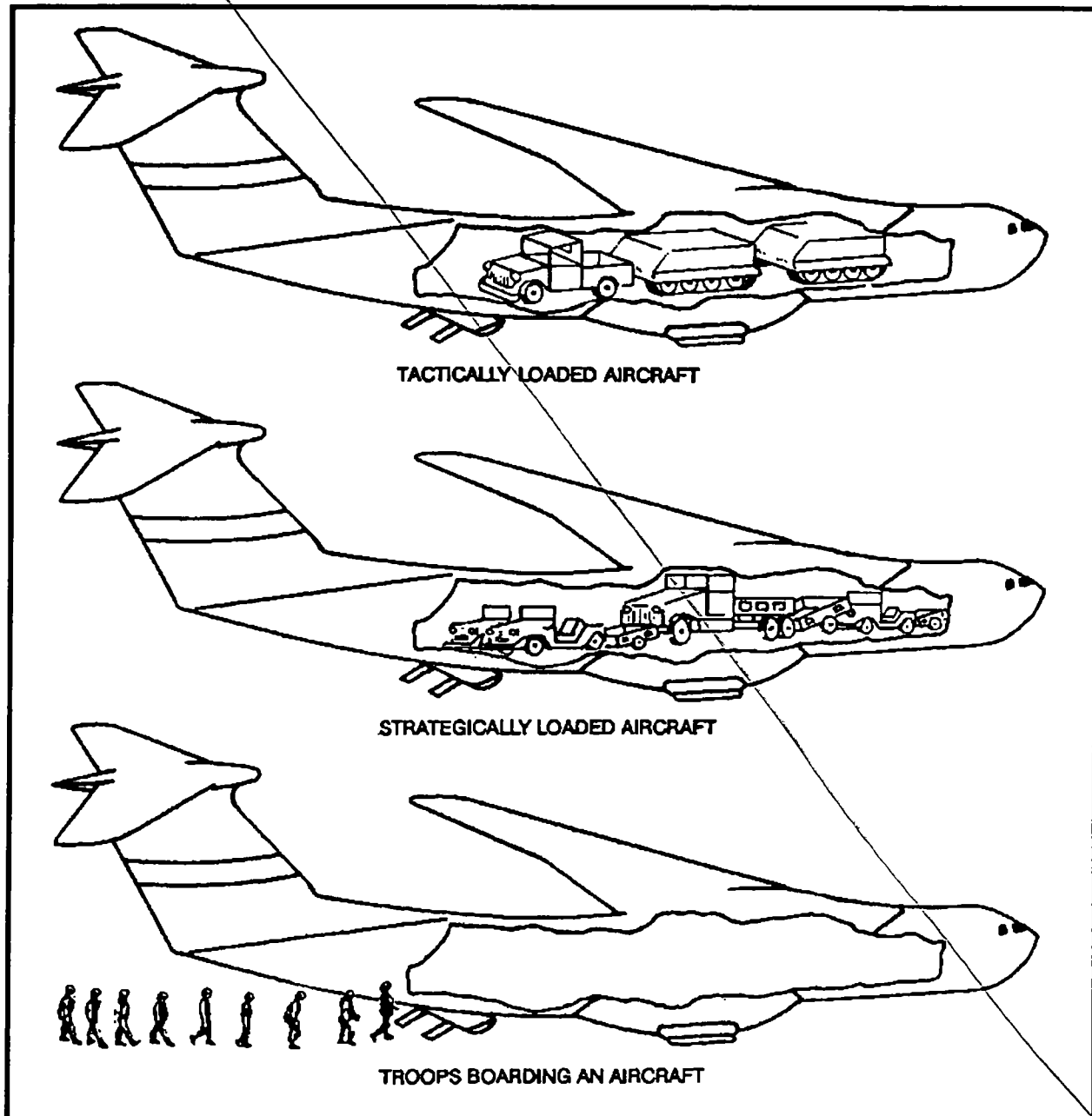


Figure 1-1. Types of Movement.

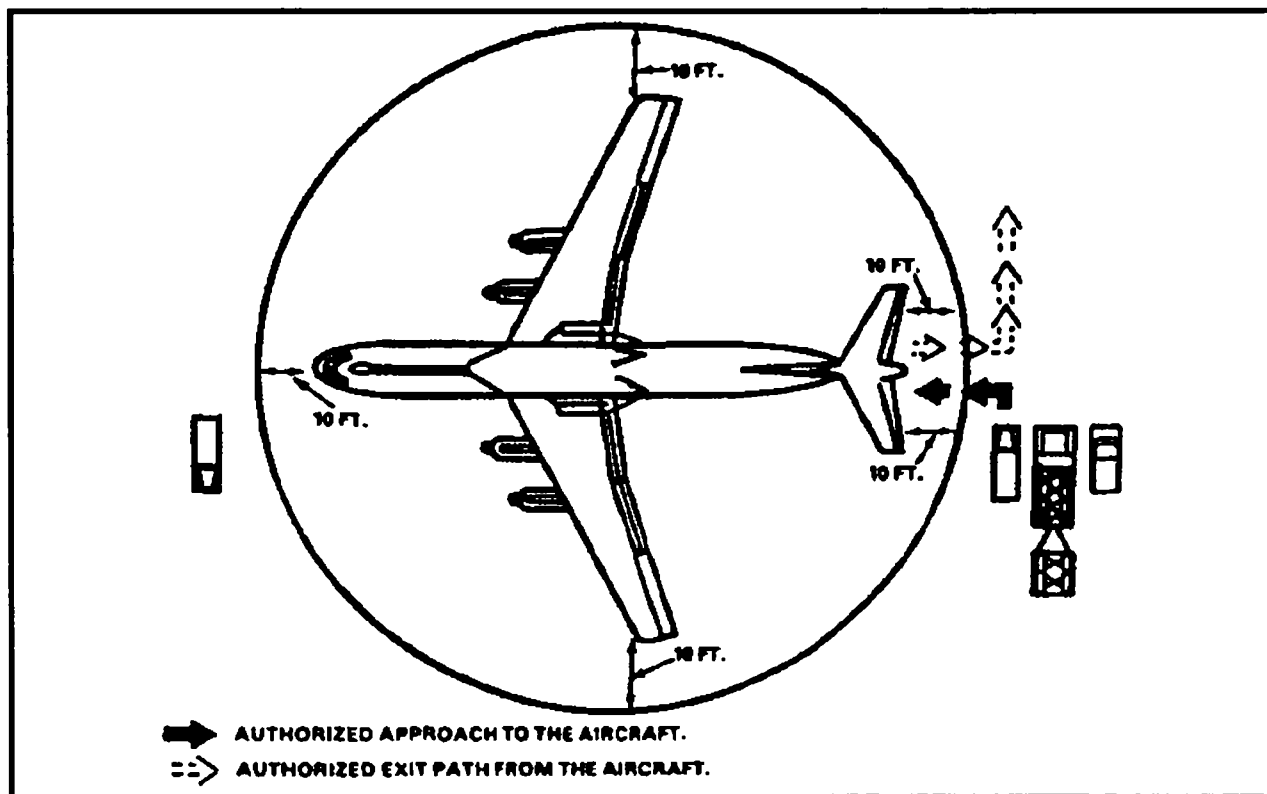


Figure 1-2. Circle of Safety.

Risk Management

Risk management is the process of making operations safer without interfering with essential mission values. The process focuses a leader on issues that could result in losses and then requires the leader to consider risk reduction measures that allow mission accomplishment while minimizing losses. The four principles of risk management are —

- Accept no unnecessary risk. An unnecessary risk is one that if eliminated would still allow for mission accomplishment.
- Make risk decisions at the proper level consistent with your local command policy.
- Accept risk only when benefits outweigh costs.
- Manage risk in the concept and planning stages whenever possible.

The risk management process is to —

- Identify the hazards that will be encountered.
- Assess the risk of those hazards by asking what are the most likely injuries or damage that might occur, and what is the probability of those losses.
- Determine what kind of control measures could be used to reduce risk. These might be speed limit controls, more supervision, scheduling, route changes, protective equipment, more training, or more indepth instructions. Once available controls are considered, decide which of those controls to implement.
- Implement controls.
- Supervise. Remember that NCOs make it safely happen.

CHAPTER 2

AIR MOBILITY COMMAND AIRCRAFT

INTRODUCTION

This chapter describes Air Mobility Command (AMC) aircraft and provides the necessary planning data to effectively prepare load plans. Personnel who prepare load plans must recertify every two years.

The AMC aircraft of main concern are the C-130, C-141, C-5, KC-10, and C-17. With some exceptions, their cargo compartments can be configured to hold general bulk or palletized cargo, vehicles/equipment, troops, paratroopers, or cargo rigged for airdrop. The KC-10 cannot be rigged for airdrop. The wide range of cargo carried by these aircraft, along with many options for loading, provides great flexibility in moving troops and equipment.

Each of these aircraft have medium- to long-range mission capability. All are equipped with roller conveyor systems for using the 463L pallet system. The C-130, C-141, C-5, and C-17 have hydraulically activated ramp systems to ease loading and unloading. The C-141, C-5, KC-10, and C-17 also have aerial refueling capability.

NOTE: The planning data for the C-17 are projected capabilities only. They do not reflect the results of any DOD-certified tests and evaluations. Use only current data as a reference for possible future capabilities. Consult affiliated AMC representatives for actual "fly away" data.

ALLOWABLE CABIN LOAD

The load planner must know the approved allowable cabin load for a particular aircraft. ACL is the weight of unit personnel, equipment, and materiel that an aircraft can carry. Several varying factors, such as distance, route to be flown, fuel load, weather, and winds, impact on the ACL. Departure and arrival airfield characteristics also factor into determining the ACL.

For general airlift planning factors, use the following ACLs:

<u>AIRCRAFT</u>	<u>ALLOWABLE CABIN LOAD</u>
C-130	25,000 pounds
C-141	50,000 pounds
C-5	150,000 pounds
KC-10	100,000 pounds
C-17	120,000 pounds

AIRCRAFT CENTER OF GRAVITY LIMITS

Another factor to consider in load planning is center of gravity (CG) limits. Each aircraft has certain limits in which it must be balanced. If an aircraft is not balanced properly, it may not take off or land safely. In extreme cases, it cannot fly safely. The load planner directly affects this balance factor when loading cargo aboard an aircraft. Loads must not cause the aircraft to exceed its balance limits. The CG of any aircraft is the point on the aircraft at which the aircraft would hang in a level, balanced horizontal position if hoisted off the ground by a cable. It is an exact and specific point on the aircraft. Fortunately, through design characteristics and mechanical devices, each aircraft allows some variation with its CG. Otherwise, load planning would be almost impossible.

These variations, or CG limits, provide the load planner with flexibility in preparing various load configurations for each aircraft. As long as the effect of the cargo weight is kept within these CG limits, the aircraft can be safely operated.

CARGO LOAD CENTER OF BALANCE
LIMITS

To keep the cargo weight within the aircraft CG limits, the cargo load center of balance (CB) must be identified. The combined center of balance (CCB) of the cargo load is then placed in the cargo compartment within a prescribed design limit for the aircraft. (See Chapter 5 for more

information.) Table 2-1 provides AMC guidelines for use in airlift planning.

In general, floating CB criteria means as the cargo weight increases, the total cargo center of balance windows decrease. When total cargo weights fall between given weights, use the most restrictive (next higher) center of balance window. For example, a 46,000-pound load on a C-141 uses the 50,000-pound window of 880-950. The airlift planner must be certified by one of the following three approved courses:

- The AMC Affiliation Airlift Planners Course.
- The US Army Air Deployment Planning Course (ADPC).
- The USMC Landing Force Training Command Pacific (LFTCPAC) Aircraft Load Planning Course.

Unit air movement planning personnel must comply with established planning data when load planning unit equipment and personnel deployments by air. (The C-17 center of balance windows

are not currently available and must be obtained after the aircraft is operationally fielded.)

The CB window numbers are referred to as fuselage station (FS) numbers. They represent the distance (in inches) aft from the aircraft reference datum (RD) line at which point the cargo load must balance. The FS numbers are clearly marked on the cabin walls to use as reference points when loading.

AIRCRAFT CHARACTERISTICS

Load planners must consider the characteristics of each aircraft. These characteristics include—

- The size of the cargo door and its location and height above the ground.
- The size and shape of the cargo compartment.
- The strength of the aircraft floor.
- The location, number, and type of seats available for airlifting troops.
- Aircraft configurations (Appendix A).

Table 2-1. Floating Center of Balance Criteria.

<u>WEIGHT</u>	<u>C-130</u>	<u>C-141</u>	<u>C-5*</u>	<u>KC-10</u>
5,000	400-550	630-1000	400-1000 (1000)	530-840
10,000	400-550	770-1000	400-1000 (1000)	530-1105
15,000	475-530	770-1000	400-1000 (1000)	542-1238
20,000	485-530	835-970	400-1370 (1040)	542-1238
25,000	510-530	835-970	400-1370 (1040)	810-1205
30,000	510-530	860-960	670-1380 (1153)	810-1205
40,000	515-530	870-950	835-1380 (1207)	942-1252
50,000		880-950	935-1380 (1242)	1022-1280
60,000		890-950	1000-1380 (1265)	1075-1298
70,000		890-940	1050-1380 (1280)	1115-1311
80,000			1085-1390 (1293)	1142-1321
90,000			1115-1390 (1309)	1165-1329
100,000			1135-1390 (1320)	1162-1335
120,000			1170-1390 (1324)	1210-1345
150,000			1200-1390 (1332)	1234-1354
175,000			1225-1390 (1338)	1235-1354
245,000			1280-1390 (1345)	
291,000			1315-1390 (1350)	

*Plan the average cargo center of balance location as near the fuselage station (in parentheses) as possible for preferred optimum fuel efficiency for the C-5.

If a complete file of Air Force publications is not available, the unit's affiliated AMC Airlift Control Squadron (ALCS) will assist the load planner. The ALCS is an extension of the unit's staff for all airlift planning. See FM 55-12 for more information on the affiliation program.

Table 2-2 is a quick reference for AMC aircraft. Refer to the individual aircraft discussed later in this chapter for more detailed information.

C-130 Characteristics

The C-130, nicknamed Hercules, is a four-engine, turbo-prop, medium-range assault transport (Figure 2-1). It is the oldest type of aircraft in the active Air Force. With an exceptionally successful record, it maintains a reputation as a dependable workhorse for the Army. The C-130 aircraft is particularly well suited for tactical air transport operations.

Table 2-2. AMC Aircraft.

Model Design	<u>C-130</u>	<u>C-141</u>	<u>C-5</u>	<u>KC-10</u>	<u>C-17</u>
Manufacturer	Lockheed	Lockheed	Lockheed	McDonnell Douglas	McDonnell Douglas
Popular Name	Hercules	Starlifter	Galaxy	Extender	
Cargo Compartment Dimensions					
Length (inches)	624	1,251	1,733	1,508	1,075
Height (inches)	108	109	162	108	148 ¹ 158 ²
Width (inches)	123 ³	123	228	218	216
Aircraft Ramp Length (inches)	132	133	(Fwd) 116 (Aft) 155	None	257
Usable Loading Space (inches)	597	1,215	1,726	1,416	1,022
Troop Load (includes flight crew)					
Over land	90 ⁴	200	73 ⁵	8(A) 10(B) 69(D)	54 SF 102 SL 158 DL
Over water	80	160	73 ⁵	69	102
¹ Under the wing. ² Aft of the wing. ³ With dual rails installed, the cargo compartment floor is limited to 106 inches wide for cargo loading. ⁴ Troop seating, except seat 11 left and 11 right must be installed in pairs. ⁵ Troop seating in the overhead troop compartment. An additional 267 seats can be configured for the cargo compartment. These 267 seats are not routinely available for load planning purposes.					
Legend					
SF - Side-facing seating only					
SL - Single centerline and side-facing seating					

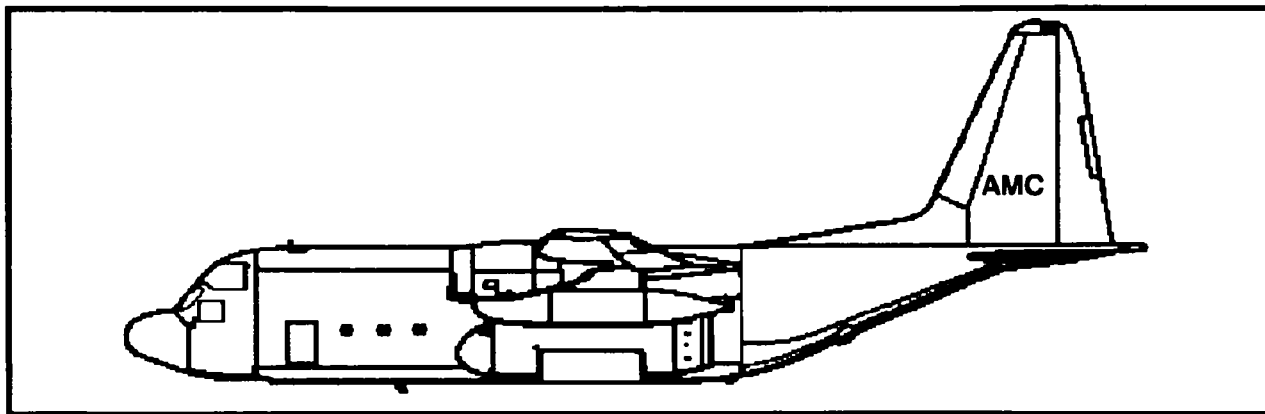


Figure 2-1. C-130 Aircraft.

Passenger Considerations. The C-130 does not have a separate passenger compartment, and passengers compete for available ACL. For planning purposes, estimate each passenger to weigh 210 pounds. This weight may vary with type of mission (refer to FM 55-12) and should be confirmed with AMC as early as possible. When using side-facing seats, plan for a maximum of 29 passengers. The C-130 will carry a maximum of 90 passengers (80 over water based on life raft capacity).

NOTE: Side-facing seats number 1 through 10 and 13 through 22 left and right must be installed in pairs. Seats 11 and 12 must be installed with 10 and 13 respectively, as these seats will not stand alone.

Palletized Cargo Restrictions. The C-130 can accommodate up to six 463L pallets. Usable surface dimensions of a 463L pallet are 84 inches long by 104 inches wide. Pallet criteria according to position, weight, and height are in Figure 2-2.

For pallet positions 3 and 4, maintain a 6-inch aisle along the narrow side of the pallet. Do not exceed an overall dimension of 84 inches long, 98 inches wide, and 96 inches high. This will provide the necessary aisleway for emergency exit of the aircraft.

For pallet position 6, maintain an 18-inch aisle. Pallet cargo dimensions will not exceed 86 inches wide, 84 inches long, and 76 inches high. This provides access to the latrine, cargo loading aids stowed in the cargo door, and to the aft escape exit hatch on the aft end of the cargo ramp.

Loading Guidance. The cargo area dimensions in Figure 2-3 are for general planning

purposes only. Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual. The schematic in Figure 2-3, extracted from DD Form 2130-2 (C-130 A/B/E/H Cargo Manifest), shows the fuselage station numbers and pallet position center of balances.

A number of loading aids are available to more conveniently load the C-130. They either come with the aircraft or are available as options from the supporting AMC TALCE or servicing aerial port. In addition to the primary loading aids in Figure 2-4, the following aids are available (all but the wheeled pry bars are in the aircraft):

- Wheeled pry bars for handling boxes and crates in the cargo compartment.
- A portable electric winch for moving cargo in and out of the aircraft.
- Internal electrical power outlets to provide power for aids when loading the aircraft.
- An auxiliary power unit to provide electricity and hydraulic pressure to assist aircraft loading.
- A public address system consisting of loudspeakers, microphones, headsets, and extension cords for giving loading instructions and to control the loading operation.
- Lighting to illuminate the cargo compartment and door area during night loading.
- Snatch blocks (loading pulleys) to help move cargo in and out of the aircraft.

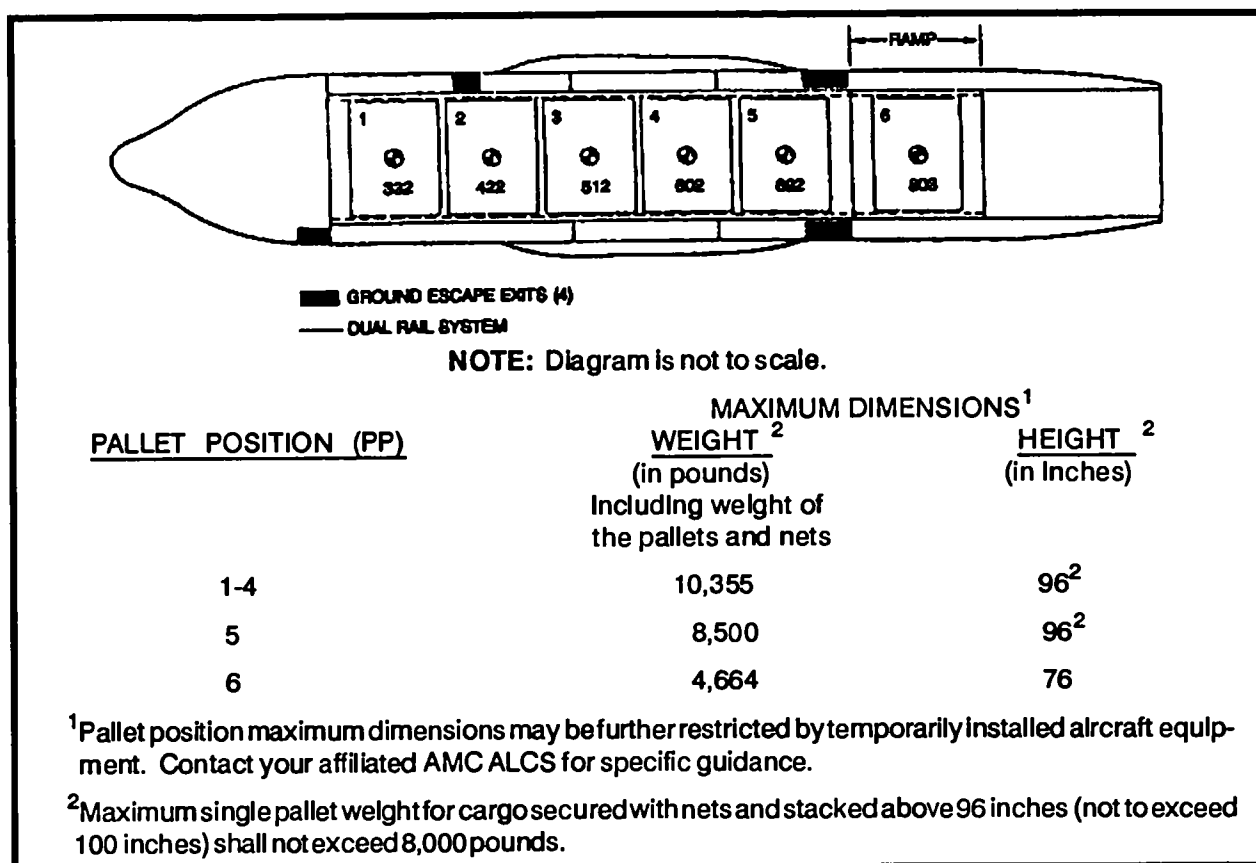


Figure 2-2. C-130 Pallet Positions.

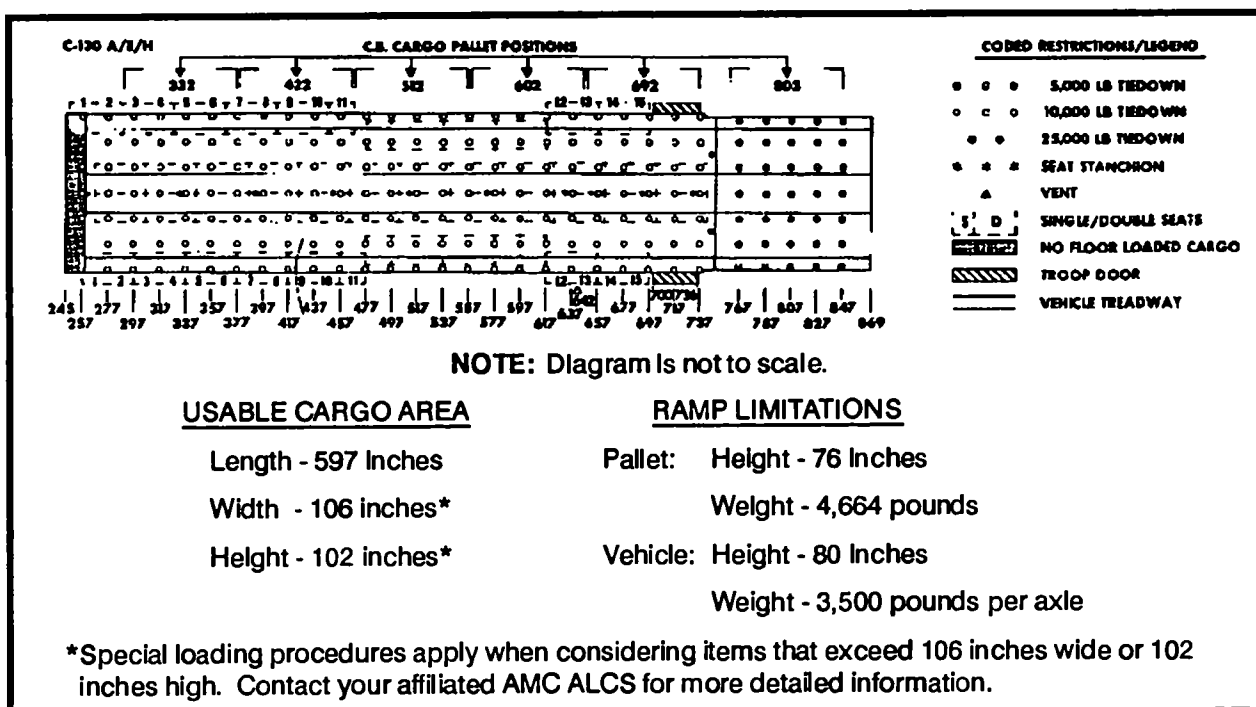
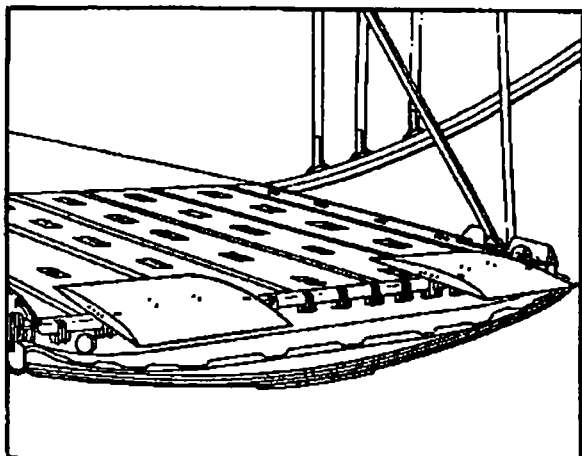
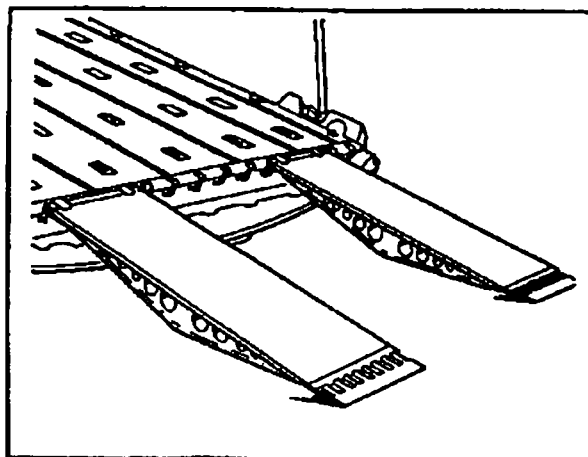


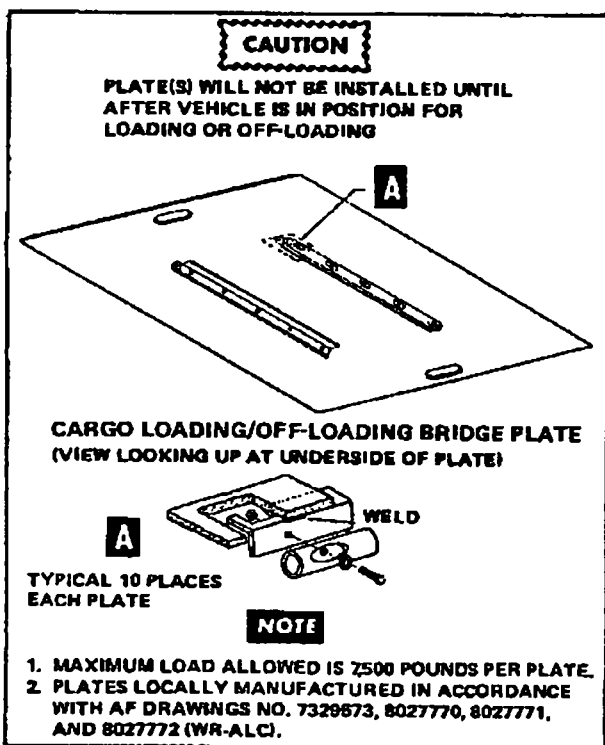
Figure 2-3. C-130 Schematic.



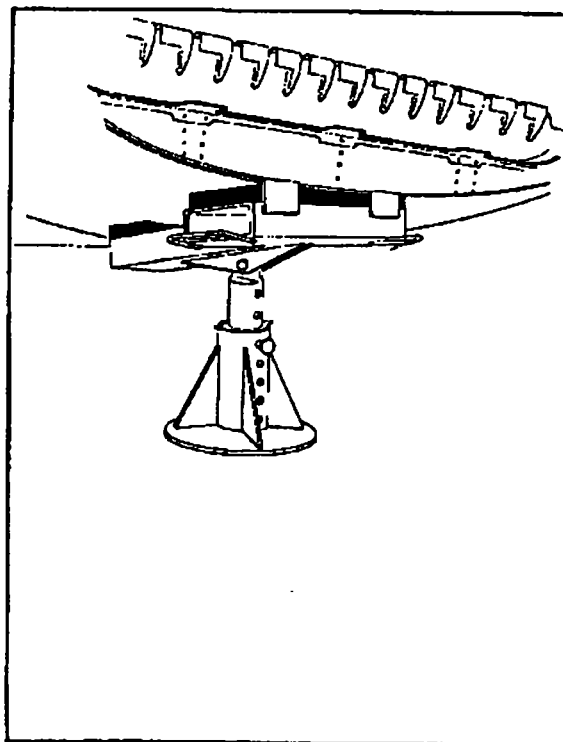
Auxiliary Truck Loading Ramps Installed



Auxiliary Ground-Loading Ramp Installed



Steel Bridge Plate



Ramp Support

Figure 2-4. C-130 Loading Aids.

Rolling Stock Restrictions. Whenever possible, plan to load rolling stock on the treadways of the aircraft as shown in Figure 2-5. Vehicles with pneumatic tires must have a minimum space of 48 inches between axles. If this space cannot be obtained, the axles are considered as a single axle. When load planning and actual loading, the single axle limitations apply (Figure 2-5). Vehicles whose operational height exceeds 102 inches must be reduced in height unless certified to be shipped at a higher height according to TB 55-46-1 or the aircraft loading manual.

When the load consists of palletized cargo or floor-loaded cargo secured with cargo straps, maintain a 30-inch space between the cargo and the nearest forward occupied seat. When cargo is secured with chains, the 30-inch rule does not apply.

Vehicles whose operational height exceeds 102 inches must be reduced in height unless

certified to be shipped at a higher height according to TB 55-46-1 or the aircraft loading manual.

Do not exceed the following limitations:

- Pounds per square inch.
- Pounds per linear foot (PLF).
- Axle weight.
- Wheel weight.

Tracked Vehicle Loading. Figure 2-6 shows an M577 tracked vehicle loaded aboard a C-130 aircraft. The following example is the method to determine loadability and placement on the aircraft floor.

EXAMPLE:

A tracked vehicle is to be loaded aboard a C-130. The tracked vehicle weighs 22,000 pounds. The weight-bearing area of the tracks is 8 feet long (the length of track that contacts the cargo floor in longitudinal plane).

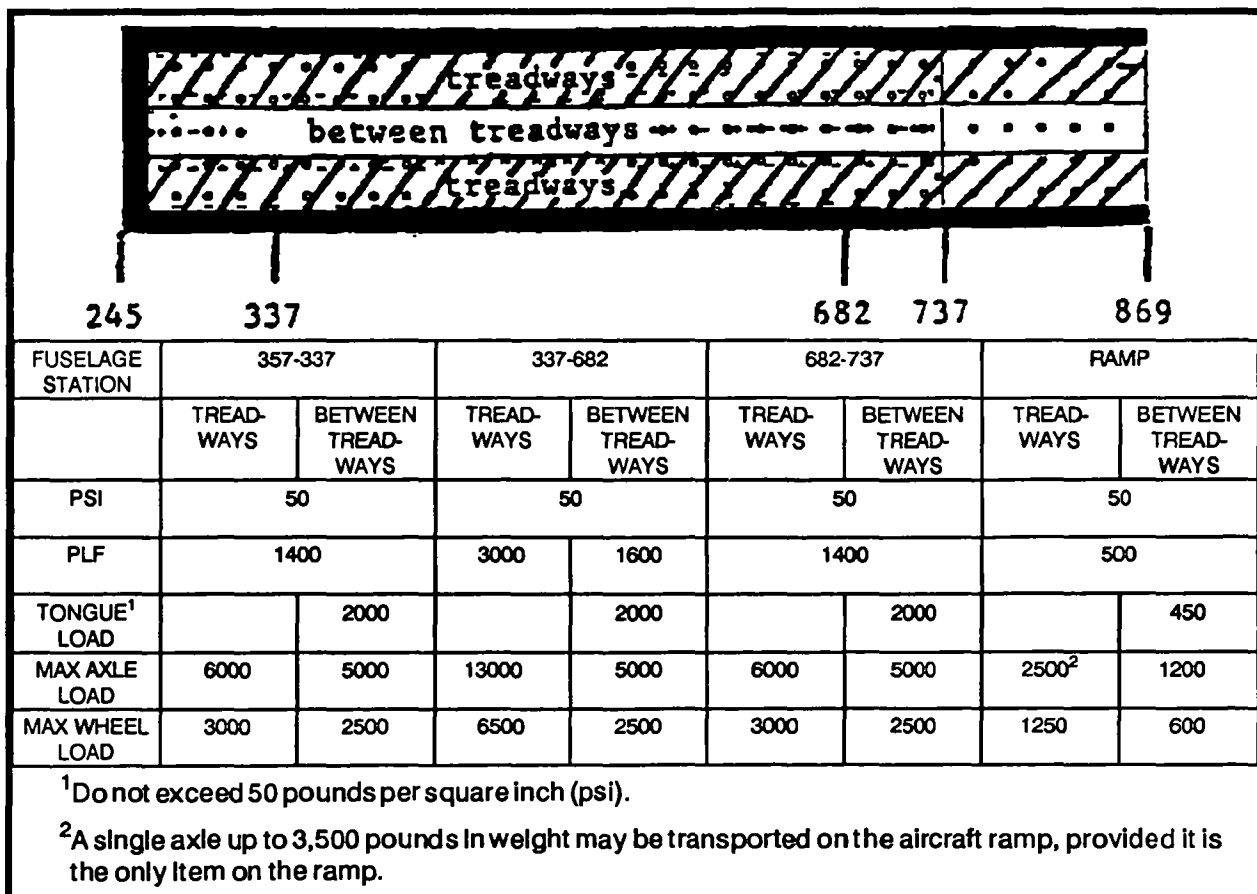


Figure 2-5. C-130 Flight Limitations Chart.

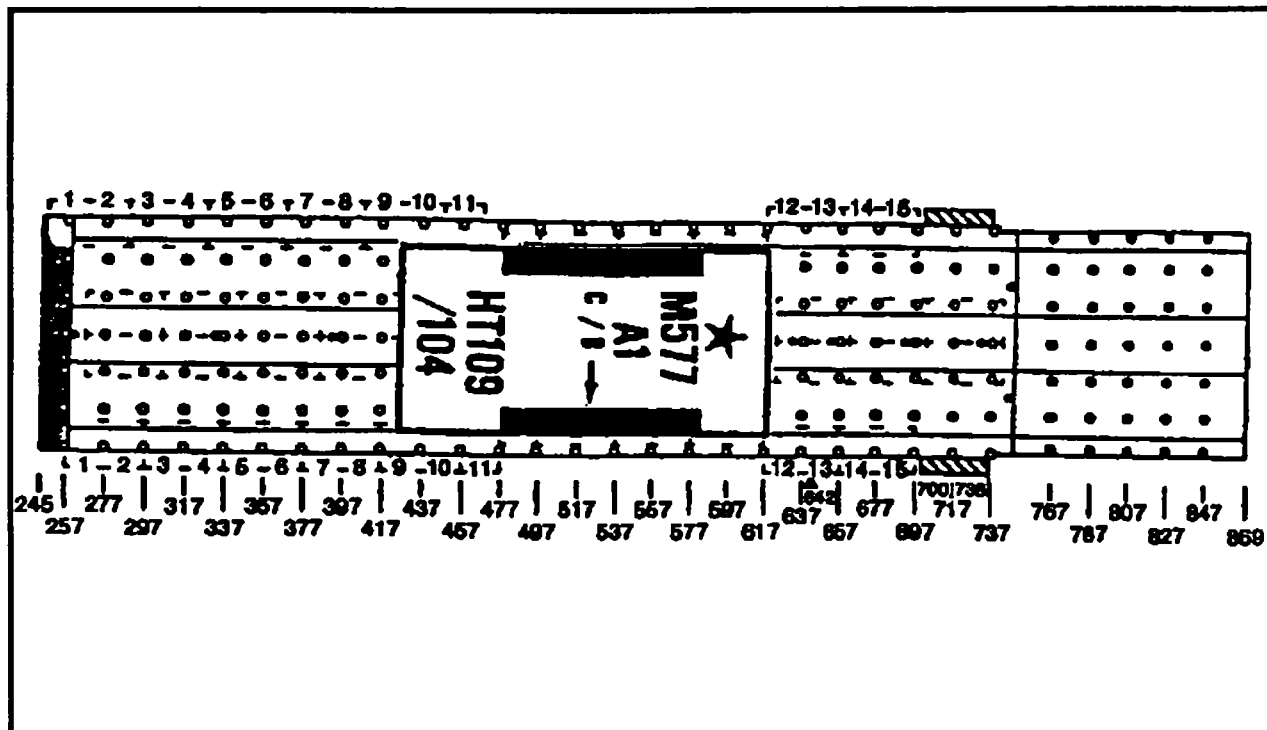


Figure 2-6. Tracked Vehicle on C-130.

To determine the pounds per linear feet, divide the weight of the vehicle by the contact portion of the track. The answer is the amount of PLF being created.

$$\frac{22,000 \text{ pounds (weight of vehicle)}}{8 \text{ feet (floor contact area of track)}} = 2,750 \text{ pounds PLF}$$

The vehicle creates 2,750 PLF. It can be safely transported, but it must be loaded between fuselage stations 337 to 682 (area where tracks must contact the aircraft floor). Allowable limit in this area is 3,000 PLF on the treadways.

Helicopter Loading. Helicopters with major disassembly can be airlifted. Table 2-3 provides data for use in mission planning. (For specific guidance, refer to T.O. 1C-130A-9.)

C-141 Characteristics

The C-141, nicknamed Starlifter, is a high-wing, heavy transport airplane with four turbofan engines (Figure 2-7). Its mission is to transport unit personnel, equipment, and materiel worldwide. The C-141 is the backbone of the strategic airlift capability of the US Air Force. It is most likely the aircraft to be used for all basic movement planning.

Table 2-3. C-130 Helicopter Loading Data.

TYPE/MODEL	LOADING METHOD	TOTAL UNITS
AH-1	Major Disassembly	1
UH-1H	Major Disassembly	1
OH-58	Major Disassembly	3
LCH-58	Major Disassembly	2
OH-6	Major Disassembly	3

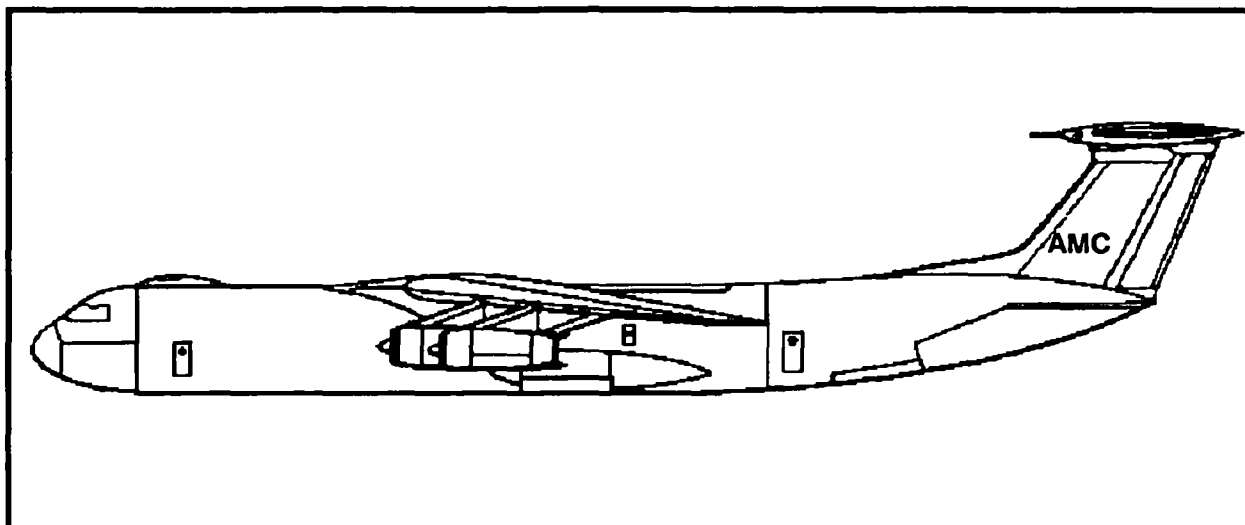


Figure 2-7. C-141 Aircraft.

Passenger Considerations. Like the C-130, the C-141 does not have a separate passenger compartment. For planning purposes, estimate each passenger to weigh 210 pounds. This weight may vary with type of mission (refer to FM 55-12) and should be confirmed with AMC as early as possible. When using side-facing seats, plan for a maximum of 98 passengers. The C-141 will carry a maximum of 200 passengers (160 over water based on life raft capacity).

NOTE: All side-facing seats *except* number 1 left and right must be installed in pairs. Seat number 1 will not stand alone.

Palletized Cargo Restrictions. The C-141 can accommodate up to 13 463L pallets. Pallet position criteria according to position, weight, and height are in Figure 2-8.

Loading Guidance. The cargo area dimensions in Figure 2-9 are for general planning purposes only. Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual. The schematic in Figure 2-9, extracted from DD Form 2130-3 (C-141B Cargo Manifest), shows the fuselage station numbers and pallet position center of balances.

To more conveniently load the C-141, a number of aids come with the aircraft or are available

as options from the supporting AMC TALCE or aerial port. The same type of equipment listed for the C-130 aircraft (Figure 2-4) is also available on the C-141.

Rolling Stock Restrictions. Whenever possible, plan to load wheeled and tracked vehicles on the treadways. Vehicles whose operational height exceeds 102 inches must be reduced in height unless certified to be shipped at a higher height according to TB 55-46-1 or the aircraft loading manual.

Do not load cargo that touches the floor or overhangs between fuselage stations 292 and 322. Do not stow any wheel loads outboard of the treadways next to the troop doors. The total combined loaded cargo weight between fuselage stations 322 and 678 will not exceed 45,000 pounds. Cargo loaded on the ramp for flight will not have the CB of cargo positioned aft of fuselage station 1473. When the load consists of palletized cargo or floor-loaded cargo secured with cargo straps, maintain a 30-inch space between the cargo and the nearest forward occupied seat. When cargo is secured with chains, the 30-inch rule does not apply. The part of a vehicle that is loaded under the crew rest facility (fuselage stations 322 to 378) will not exceed 80 inches in height measured from the aircraft floor. Do not exceed the limitations in Figure 2-10.

To determine aftmost axle location, use the procedures in Figure 2-11.

Tracked Vehicle Loading. When planning air movement, there are two types of tracked vehicles: combat vehicles and construction vehicles. The basic difference is the rubber pad protection on the tracks that prevents damage to the ramp and the aircraft floor.

All vehicles with metal tracks, cleats, studs, or other gripping devices that will damage the floor require rolling and parking shoring (see Chapter 6). Shoring must be 3/4 inch plus the length of the metal track, cleat, or stud. Tracked vehicles with serviceable rubber pads do not require shoring if the aircraft floor limitations are not exceeded. Rubber pads must protrude beyond the steel track so that no portion of the metal track contacts the cargo floor.

Combat vehicles. Tracked combat vehicles have rubber pads on the individual track segments. Generally, they are limited to a maximum practical

gross weight of 44,000 pounds. More specific limits are as follows:

<u>MAXIMUM AXLE WEIGHT (in pounds)</u>	<u>MINIMUM REQUIRED SHORING</u>
5,000	3/4 inch
5,001 to 5,500	1 inch
5,501 to 6,500	1 1/2 inch
6,501 to 7,900	2 inch
7,901 to 10,000	3 inch

Approximate axle weights for vehicles with five axles or less by dividing the gross vehicle weight (GVW) by the number of axles minus 0.5. For example, the weight of a vehicle with five axles would be divided by 4.5.

Approximate axle weights for vehicles with six or more axles by dividing the gross vehicle weight by the number of axles minus 1.0. For example, the weight of a vehicle with seven axles would be divided by six.

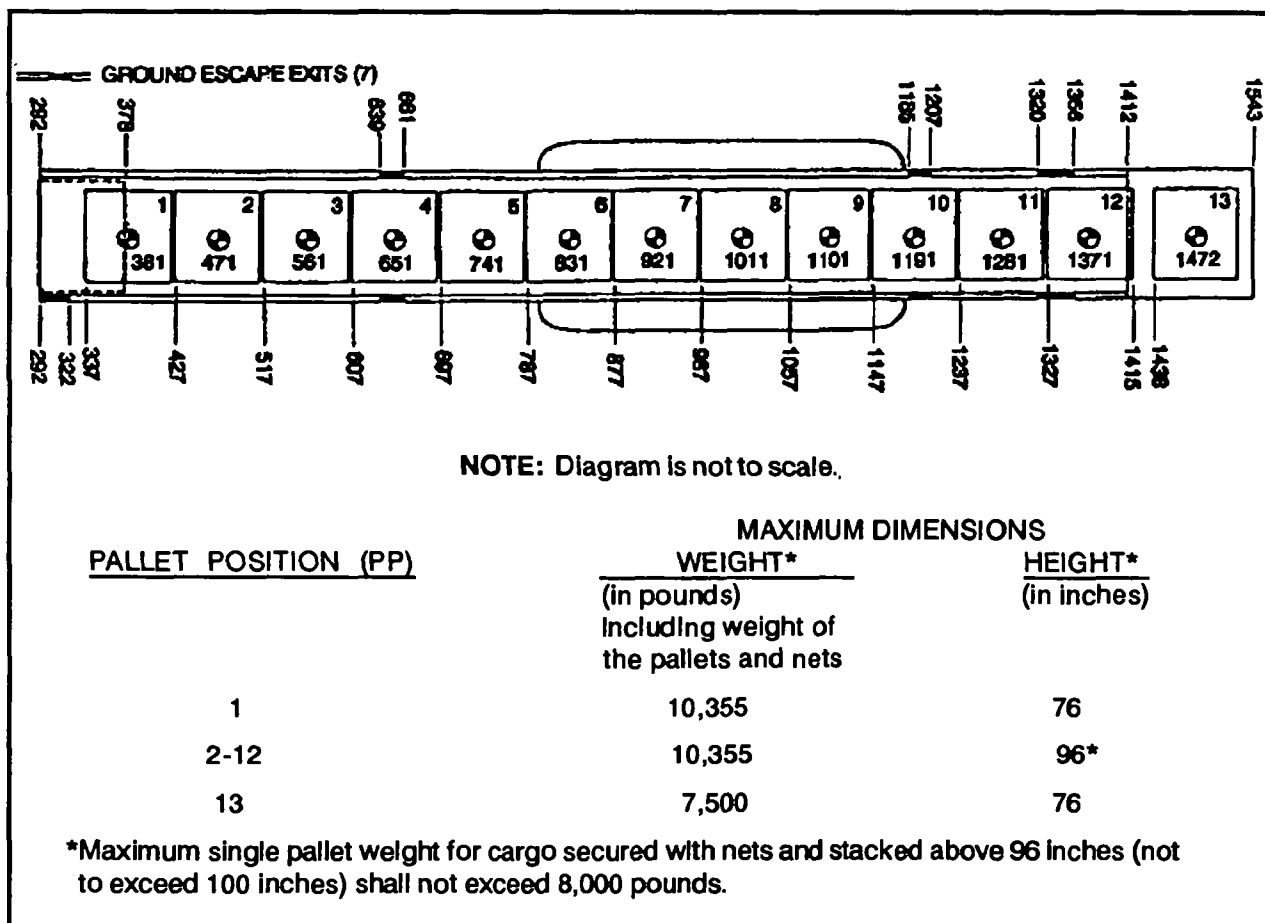
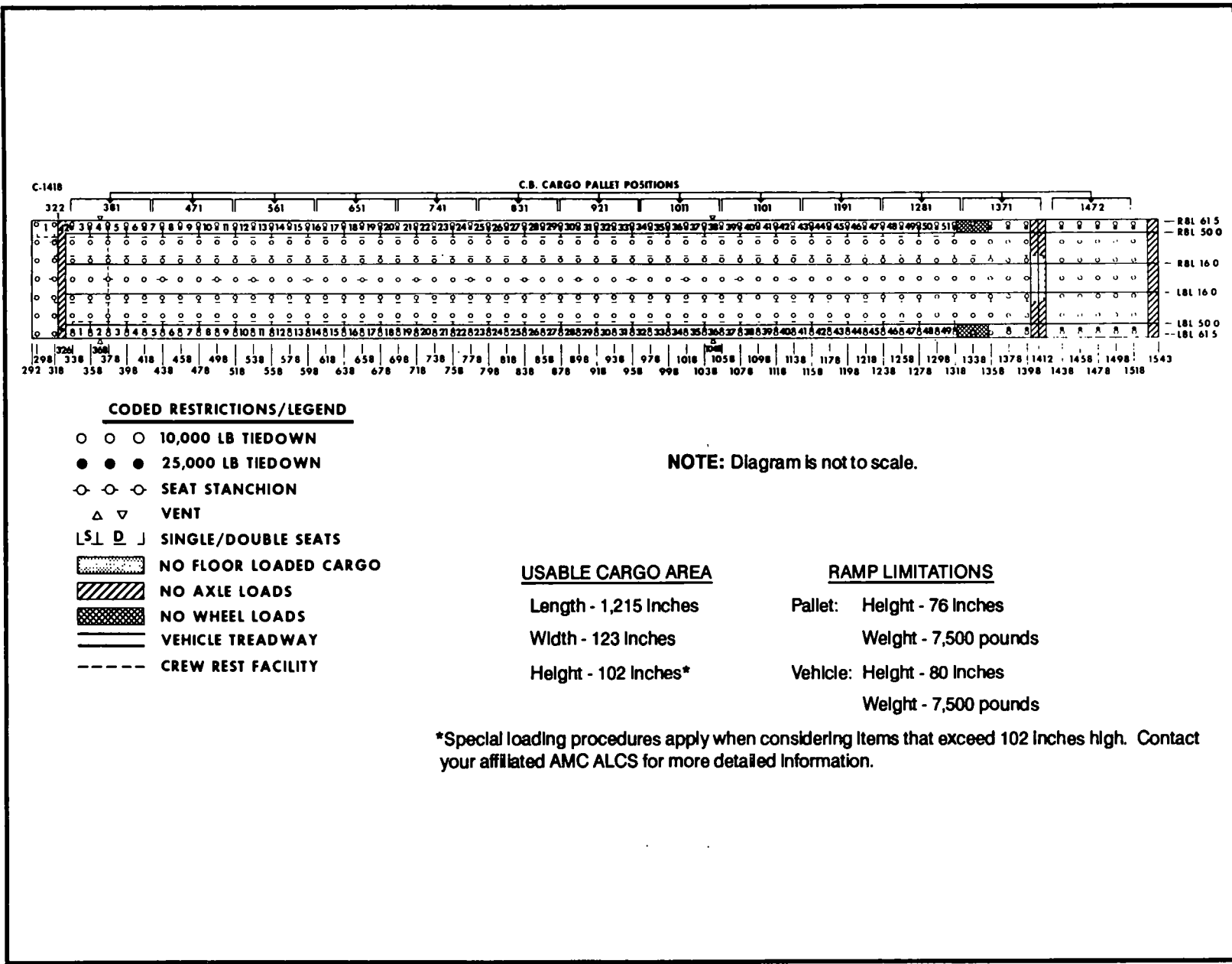


Figure 2-8. C-141 Pallet Positions.

Figure 2-9. C-141 Schematic.



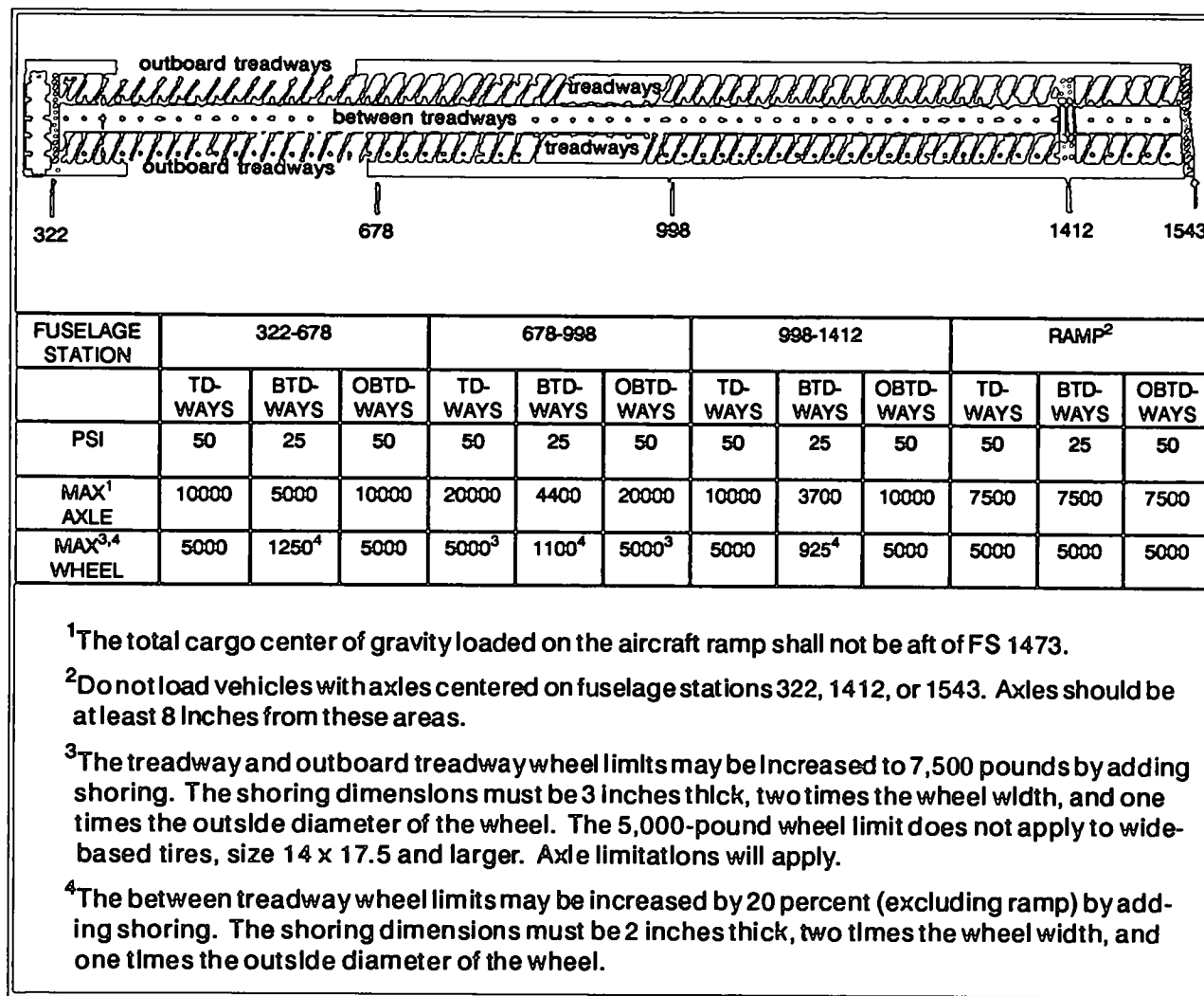


Figure 2-10. C-141B Flight Limitations Chart.

Construction vehicles. Tracked construction vehicles usually do not have rubber pads on the track segments. They are generally limited to a maximum practical gross weight of 44,000 pounds. Tracked vehicles with cleats require rolling and parking shoring. Shoring must be a minimum of 3/4 inch plus the length of the track. For example, a dozer with 3 1/4-inch cleats would require 4 inches of rolling and parking shoring. Vehicles heavier than 32,500 pounds must be loaded straight in from a trailer or K loader. Vehicles that exceed any of these criteria or have unusual suspensions require special analysis and loading and shipping procedures. Load planners should obtain HQ AMC ALCS or affiliated ALCS guidance.

The following example shows how to determine the maximum axle weight for a tracked vehicle.

EXAMPLE:

Gross vehicle weight = 28,950 pounds

Number of axles = 5

$$5 \text{ axles or less} = \frac{\text{GVW}}{\text{number of axles} - .5} = \frac{28,950}{4.5} = 6,434$$

Computed load per axle = 6,434 pounds

1 1/2 inches of shoring is required.

Helicopter Loading. Table 2-4 provides data for use in mission planning. (For specific guidance, refer to T.O. 1C-141B-9.)

C-5 Characteristics

The C-5, nicknamed Galaxy, is a high-winged, long-range, heavy-lift transport aircraft (Figure 2-12). Its primary function is to airlift outsized cargo. The aircraft is designed for global, intertheater operations. Unique features of this aircraft are the forward cargo door (visor) and ramp and the aft cargo door system and ramp. These features allow drive-on/drive-off loading and unloading. A vehicle can actually be driven through the aircraft.

The unit should not use the C-5 as a convenience to load planning. For general planning purposes, the C-5 is only used for cargo that is outsized to the C-141 aircraft. Unless operations orders state differently, cargo certified to fit the C-141 loading envelope will be planned on a C-141 aircraft. Higher priority missions may require HQ AMC/TACC to substitute C-5 aircraft for a ratio of C-141s. Units must maintain flexibility to allow for this type of change. Units must maintain open communications with their affiliated AMC ALCS for everyday guidance in this area.

DETERMINING THE AFTMOST AXLE LOCATION

- Step 1. Determine the weight of the cargo on the ramp.
- Step 2. Determine the weight of the aftmost axle.
- Step 3. Add the results of Steps 1 and 2 above.
- Step 4. Determine the aftmost axle location by locating the value of the result of Step 3 on the horizontal scale, projecting this point vertically to the curve and then horizontally to the vertical scale, and reading the results.

EXAMPLE:

Ramp cargo weight = 3,900 pounds

Aft axle weight = 8,600 pounds

Sum of Steps 1 and 2 = 3,900 + 8,600 = 12,500 pounds

NOTE: See the dashed line in the chart. The axle must be at least 23 inches forward of the ramp hinge.

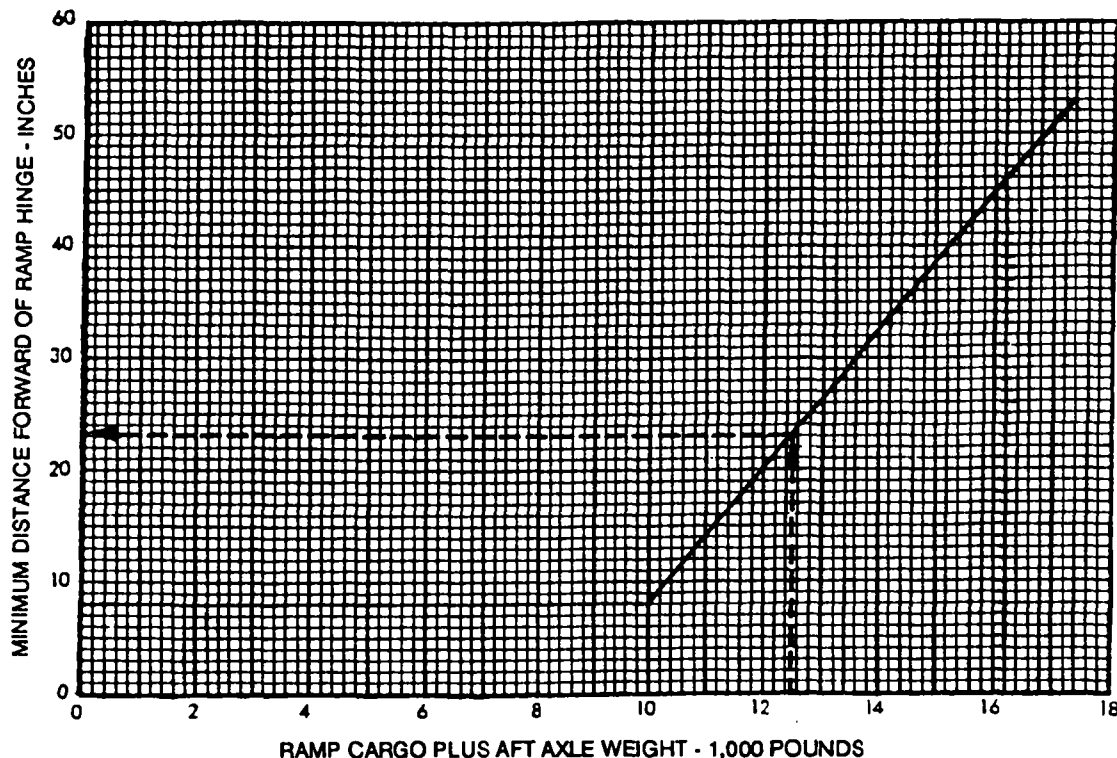
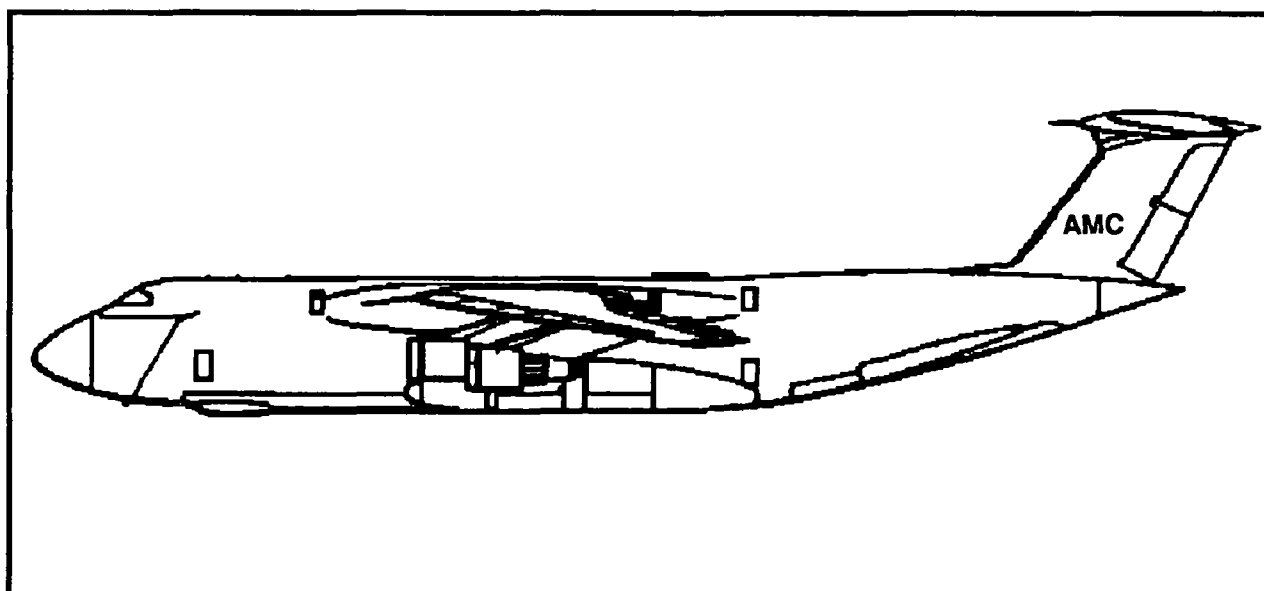


Figure 2-11. C-141B Axle Distance/Ramp Weight Chart.

Table 2-4. C-141 Helicopter Loading Data.

<u>TYPE/MODEL</u>	<u>LOADING METHOD</u>	<u>TOTAL UNITS</u>
UH-1D/H/V	Palletized (Fuselage and Boom Side Saddle)	4
	Straight-In (w/wo Tail Boom)	3/3
	Ground Ramp (w/wo Tail Boom)	2/2
UH-1N	Palletized (Fuselage and Boom Side Saddle)	3
	Straight-In (w/wo Tail Boom)	3/3
	Ground Ramp (w/wo Tail Boom)	2/3
UH-1A/B/C/K	Palletized (Fuselage and Boom Side Saddle)	4
	Straight-In (w/wo Tail Boom)	3/3
	Ground Ramp (w/wo Tail Boom)	2/3
UH-1E/F/L/M	Palletized (Fuselage and Boom Side Saddle)	4
	Straight-In (w/wo Tail Boom)	3/3
	Ground Ramp (w/wo Tail Boom)	2/2
OH-58	With Tail Boom	6
	Without Tail Boom	7
	Without Tail Boom on Shipping Skids	10
AH-1	Ground/Ramp/Straight-In	3
	Palletized	4
OH-6	Fully Assembled	6
UH-60	Ground Ramp	2
AH-64	Ground Ramp	2

**Figure 2-12. C-5 Aircraft.**

Passenger Considerations. The troop compartment is in the upper deck area on the C-5 aircraft. It is a self-contained compartment with a galley, two lavatories, and 73 available passenger seats (CB at FS 1675). An additional 267 airline seats may be installed on the cargo compartment floor (maximum combined total of 329 troops including the aircrew over water).

Palletized Cargo Restrictions. The C-5 can accommodate up to 36 463L pallets. Pallet criteria according to position, weight, and height are listed below.

<u>PALLET POSITION</u>	<u>MAXIMUM WEIGHT*</u>	<u>MAXIMUM HEIGHT*</u>
1-5	7,500 pounds	96 inches
3-34	10,355 pounds	96 inches
35-36	7,500 pounds	70 inches

*Maximum single pallet weight for cargo secured with nets and stacked above 96 inches (not to exceed 100 inches) shall not exceed 8,000 pounds.

Loading Guidance. The cargo area dimensions in Figure 2-13 are for general planning purposes only. The schematic in Figure 2-13, extracted from DD Form 2130-1 (C-5A/B Cargo Manifest), shows the fuselage station numbers and pallet position centers of balance.

The cargo compartment design, dimensions, and payload capability have been optimized to deploy units, personnel, equipment, and materiel. The compartment has a forward cargo door (visor) and ramp and an aft cargo door system and ramp. The visor door, when closed, forms the nose of the aircraft. The forward ramp extension is stowed in the vertical position. The aft pressure door, also used as a ramp extension, may be raised to a horizontal position to permit airdrop operations.

For general cargo and vehicular tie-down provisions, the cargo floor of the C-5 has 304 flush, permanently installed rings. Each ring can sustain a design limit load of 25,000 pounds. The tie-down rings are designed to receive either one hook from a 25,000-pound restraint device or two hooks from 10,000-pound restraint devices.

Another feature that facilitates and expedites loading and unloading operations is the kneeling capability. Kneeling the landing gear permits the cargo compartment floor to be lowered

approximately 10 feet to about 3 feet above the ground. This kneeling feature was incorporated for two reasons: to facilitate loading operations by lowering the cargo ramps for truck-bed and ground loading and to reduce the ramp angles for loading and unloading vehicles.

Figure 2-14 shows the cargo floor and ramp angles for the kneeling condition. It also shows the C-5 nose up when aft-kneeled, nose down when forward-kneeled, and level when level-kneeled.

Note the dimensional data provided with the aircraft sections shown in Figure 2-15. The diagrams depict the front of the C-5 facing aft.

Figure 2-16 shows the details of the forward cargo opening with the visor in the raised position. The side profile of the cargo floor shows the ramp in the ground loading position in the stowed position. The front view of the cargo opening shows detailed dimensions of the opening.

To ground load or unload vehicles, the pressure door is hinged to the ramp as a ramp extension and lowered to contact the ground. Figure 2-17 shows the aft cargo ramp in the ground loading position.

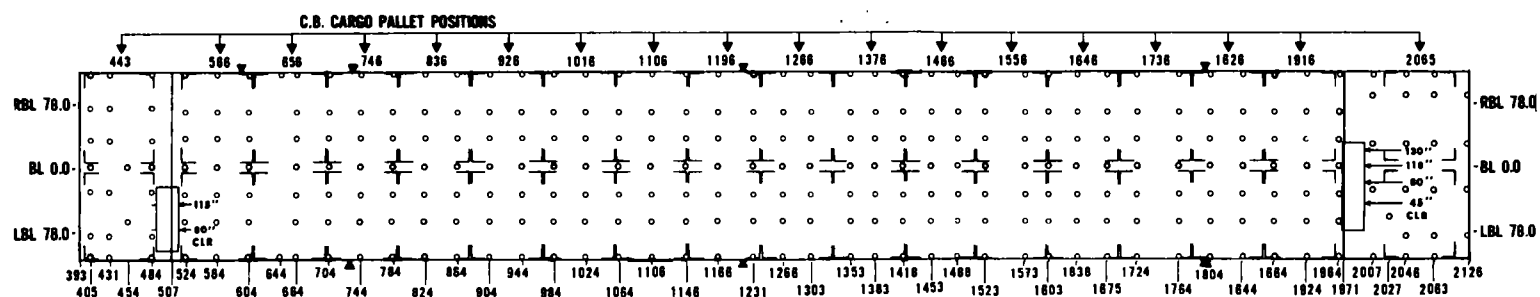
Rolling Stock Restrictions. The cargo floor is a load-carrying structure across its whole width. Vehicles can traverse its whole area and maneuver freely during loading operations. In flight, single 36,000-pound axle loads or a combination of axles weighing up to 36,000 pounds may be carried on any continuous 40-inch longitudinal length of cargo floor area between fuselage stations 724 and 1884. Figure 2-18 also shows the in-flight loading limits on other floor areas and on the ramps. The capability of the ramps and floor are such that tanks and other tracked vehicles weighing up to 129,000 pounds can be loaded and transported.

Helicopter Loading. Table 2-5 provides data for use in mission planning. (For specific guidance, refer to T.O. 1C-5A-9.)

KC-10 Characteristics

The KC-10, nicknamed Extender, is a swept-wing, wide-body tri-jet with a dual-purpose mission as an aerial refueler and cargo/passenger aircraft (Figure 2-19). Unit personnel, equipment, and materiel are carried on the upper deck, and fuel tanks are contained in the lower compartments of the fuselage.

Figure 2-13. C-5 Schematic.



NOTE: Diagram is not to scale.

USABLE CARGO AREA

Length - 1,726 Inches

Width - 228 Inches

Height - 158 Inches

Table 2-5. C-5 Helicopter Loading Data.

<u>TYPE/MODEL</u>	<u>LOADING METHOD</u>	<u>TOTAL UNITS</u>
AH-1 Wings Removed	Disassembled	12
AH-1S Wings Installed	Assembled/Minimum Disassembly	5/7
UH-1	Minimum Disassembly	7/8
UH-1	Disassembled	11
OH-6A	Assembled	26
CH-46	Disassembled	3
CH-47 Load thru Aft Doors	Disassembled	2
CH-47 Load thru Fwd Doors	Disassembled	3
CH-54	Disassembled	2
OH-58	Minimum Disassembly	13
OH-58	Disassembled	22
UH-60	Minimum Disassembly	6
AH-64	Minimum Disassembly	6

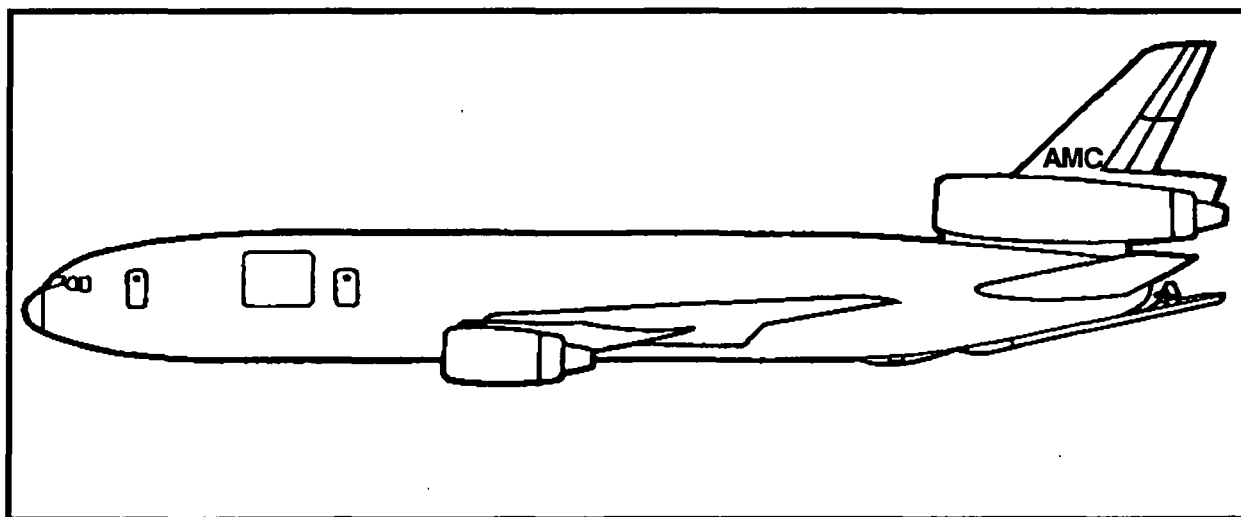


Figure 2-19. KC-10 Aircraft.

Passenger Considerations. When planning passenger movement on the KC-10, the limiting factor will be the configuration requested or

approved (Appendix A). Planning weight for passengers will be 180 pounds. The KC-10 may carry up to 69 passengers (69 over water).

Palletized Cargo Restrictions. The KC-10 uses a rounded cargo compartment to maximize cargo-carrying capability. It can accommodate up to 27 463L pallets. Normally, a maximum of 25 pallet positions will be authorized. Usable surface dimensions of a pallet are 104 inches long by 84 inches wide. Pallet criteria according to position, weight, and height are in Figures 2-20 and 2-21.

For ease of planning, the two pallet profiles in Figure 2-22 will simplify pallet build-up. The two pallet profiles are—

- 104 inches long x 84 inches wide x 70 inches high for pallet positions 2 through 10.
- 104 inches long x 65 inches wide x 60 inches high for pallet positions 11 and 12.

These profiles may be exceeded to maximize use of the cargo compartment. However, the maximum profile limits (Figures 2-20 and 2-21) will not be exceeded.

Loading Guidance. The following cargo area dimensions are for general planning purposes only:

USABLE CARGO AREA

Length - 1,416
Width - 218
Height - 102

NOTE: Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual.

The schematics in Figures 2-23 and 2-24, extracted from DD Forms 2130-6 and 2130-7 (KC-10 cargo manifests), show the fuselage station numbers, seating arrangements, and pallet position centers of balance.

Restraint criteria for other than netted cargo are as follows:

RESTRAINT CRITERIA*

DIRECTION	REQUIREMENT
Forward (with cargo barrier net)	1.5 g's
Forward (without cargo barrier net)	9.0 g's
Aft	1.5 g's
Lateral	1.5 g's
Vertical	2.0 g's

*See Chapter 7, Cargo Restraint.

There is no provision for floor loading unit equipment or passenger baggage. All hand-carried items, such as crew-served weapons, rucksacks, and web belts, must either fit under the airline-style seating or be palletized.

Rolling Stock Restrictions. The unique loading requirements and limitations for the KC-10 require special attention. Any time the use of a KC-10 for airlift is anticipated, arrangements must be made for a wide-body loader at the location. Unlike other AMC aircraft, the KC-10 does not have a ramp at ground level to roll equipment on and off. The cargo door is about 15 feet above ground level. Also, unlike other cargo aircraft, the KC-10 cargo floor cannot withstand the stress of heavy axle floor loading. Therefore, the 463L pallets must be used as a subfloor whenever cargo or baggage is to be loaded aboard this aircraft. Also, because of the location of the cargo door, cargo width and height must be within the cargo door limits (Figure 2-25).

There are three acceptable loading methods for use with the 463L pallet. The actual method used to load equipment depends on numerous variables including allowable loading time and availability of materials-handling equipment (MHE). (Wide-body loaders, K loaders, and forklifts are needed to load and move pallets.) The methods are described as follows:

- The first method is to prepalletize and secure cargo on individual 463L pallets before loading. This method requires the least amount of time for loading.
- The second method is to place empty 463L pallets into the aircraft to create a pallet subfloor. The equipment is then driven or pushed into place and secured for flight.
- The third method uses a combination of the first two methods. The combination method provides the flexibility for last minute changes and requires less use of MHE.

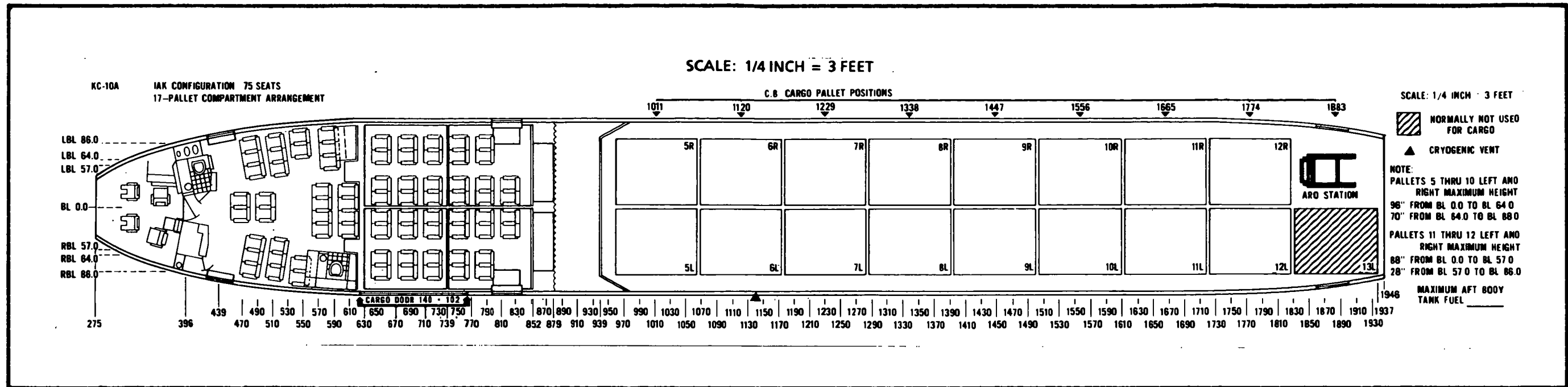


Figure 2-23. KC-10 Schematic-- 17 Pallets Configuration.

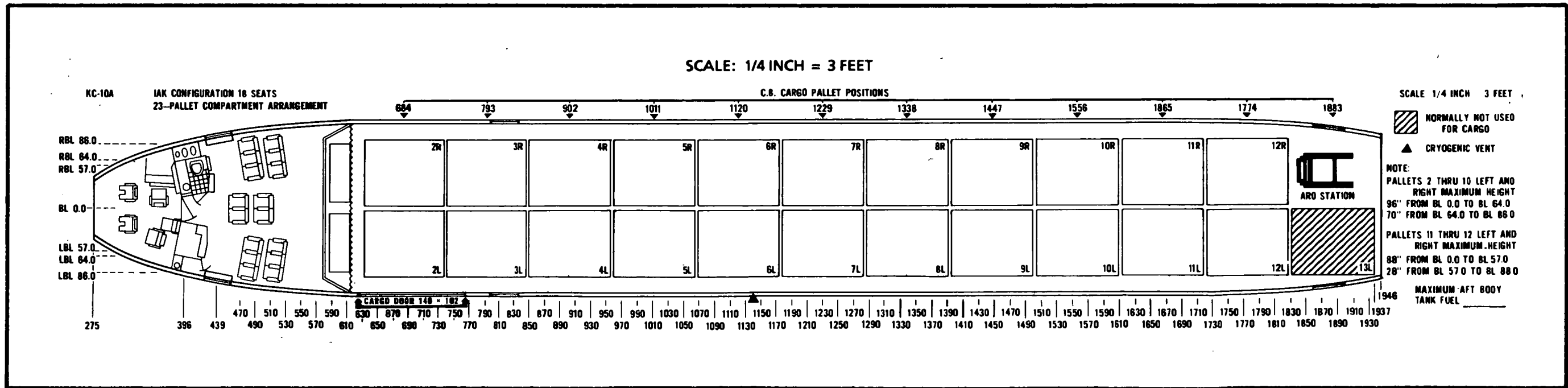


Figure 2-24. KC-10 Schematic-- 23 Pallets Configuration.

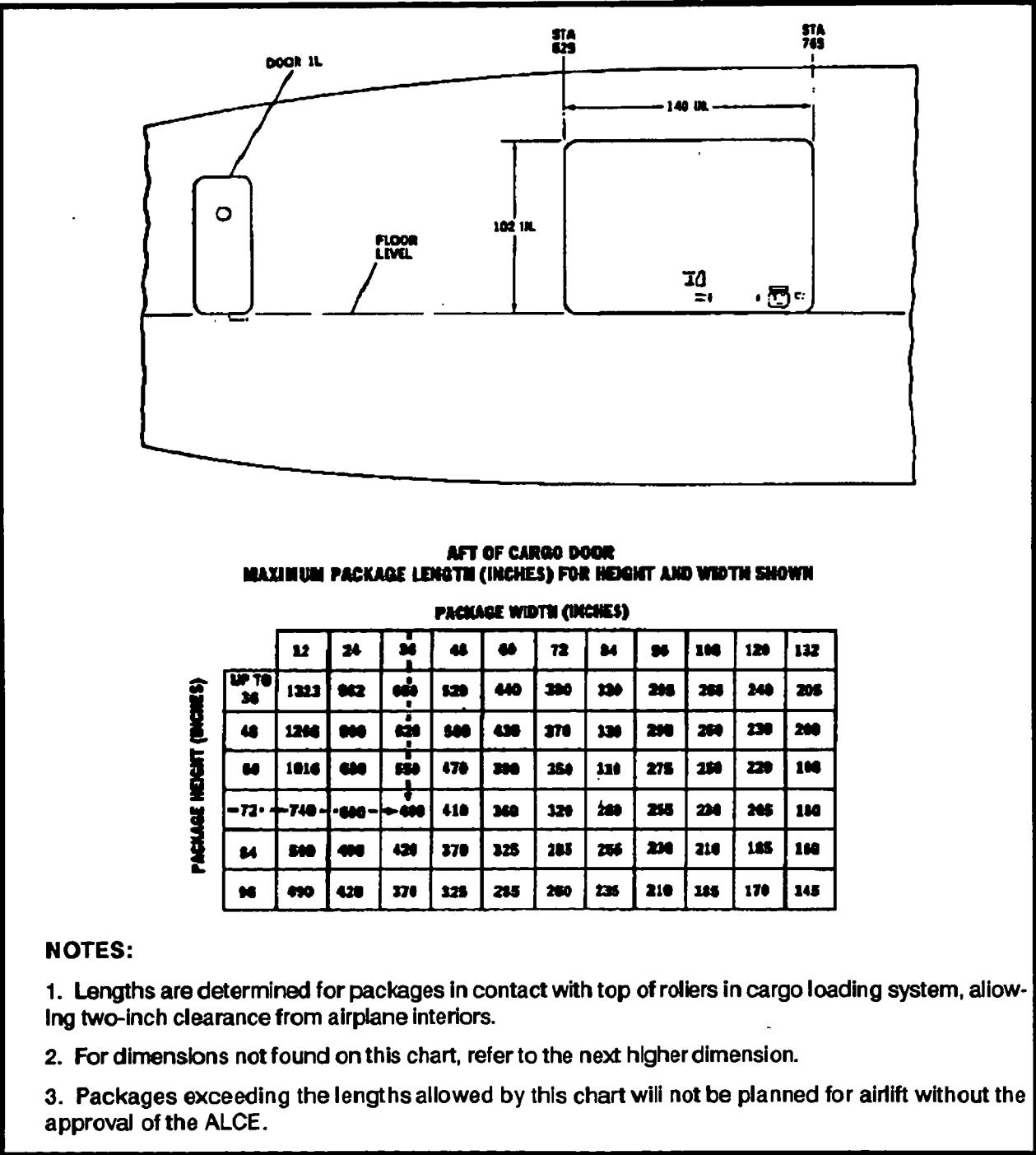


Figure 2-25. KC-10 Package Size Chart—Cargo Loaded Aft of Cargo Door.

The pallet profile limitations also apply to wheeled equipment. In addition, allowable axle weights and axle separations (Figures 2-26 and 2-27) must not be exceeded. (Exceptions are allowed according to T.O. 1C-10(K)A-9. Section V

outlines specific loading procedures for items that do not fit within general loading criteria or require a waiver of the aircraft limitations; for example, M-35A2 2 1/2-ton cargo truck (without winch), Figures 2-28, 2-29, and 2-30.

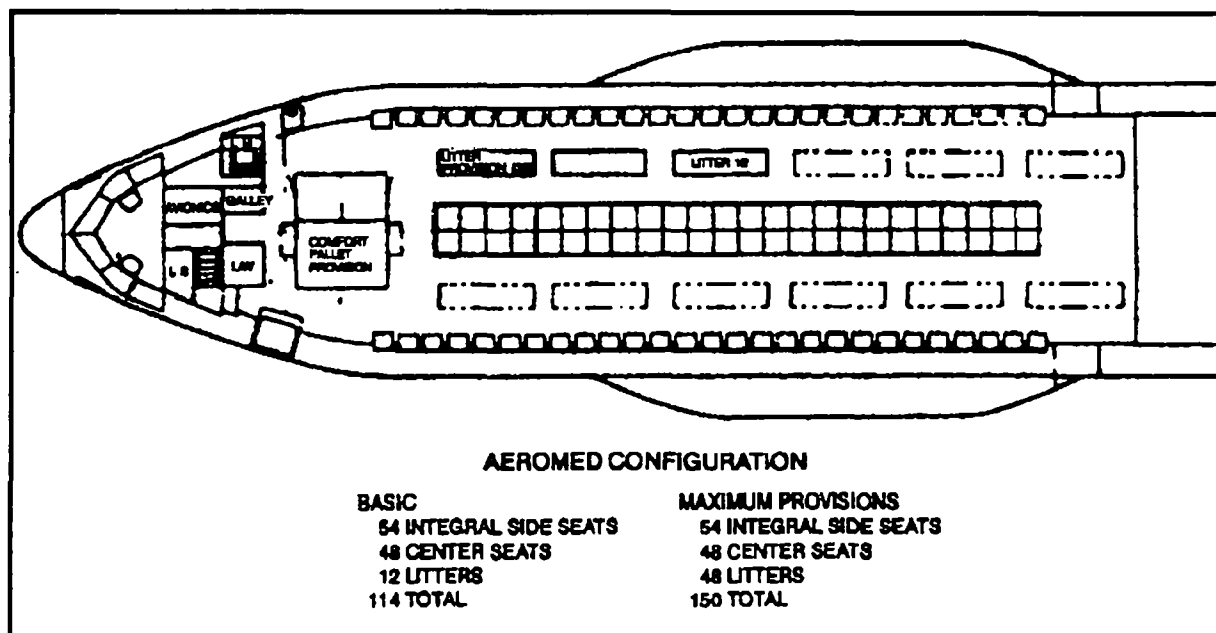
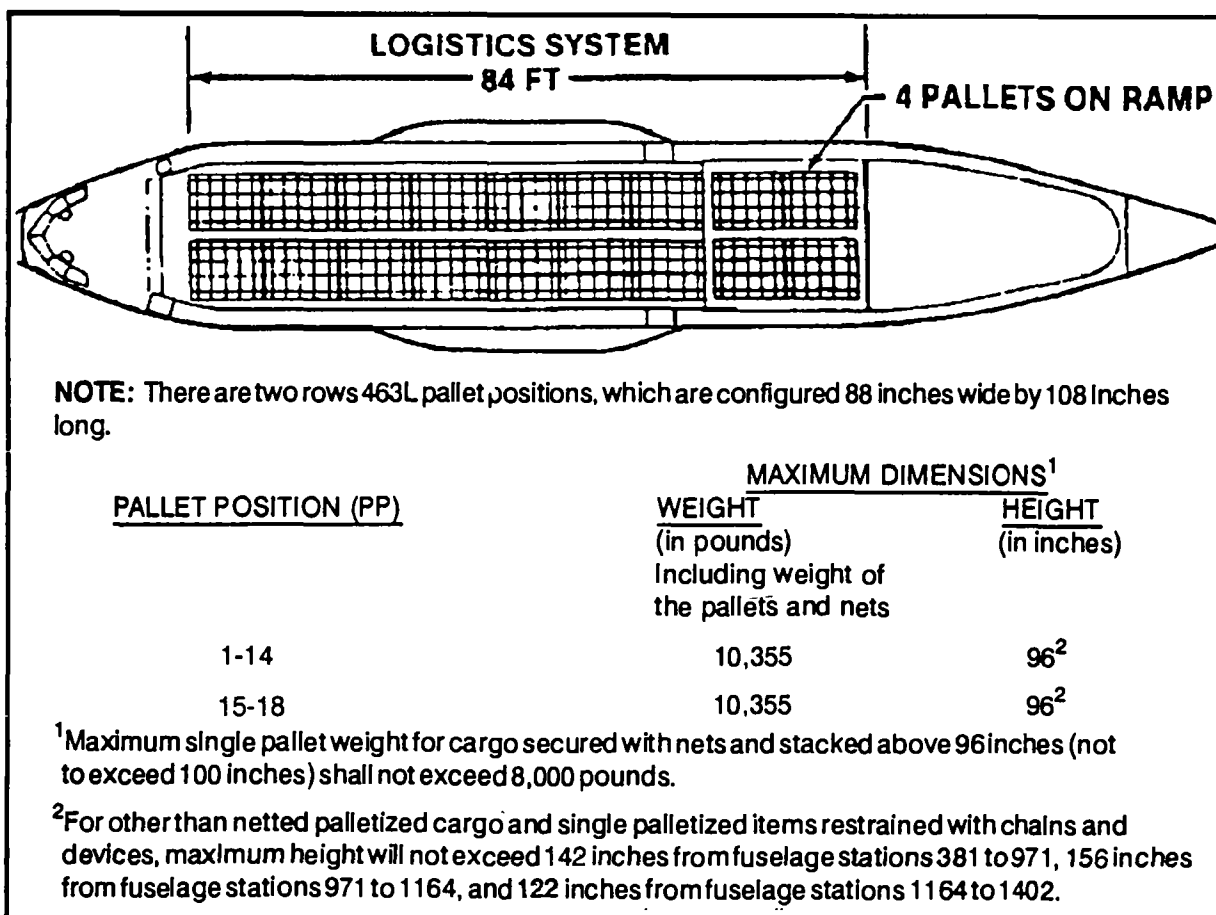


Figure 2-37. Aeromed Configuration.



* Figure 2-38. C-17 Pallet Positions.

Loading Guidance. The cargo area dimensions in Table 2-6 are for general planning purposes only (Figures 2-39 and 2-40):

The schematic in Figure 2-41 shows the fuselage station numbers and cargo tie-down locations.

Rolling Stock Restrictions. The cargo floor is a load-carrying structure across its whole width. Vehicles can traverse its whole area and maneuver freely during loading operations. In flight, single 40,000-pound axle loads or a combination of axles weighing up to 40,000 pounds may be carried on any continuous 42-inch longitudinal length of

cargo floor area between fuselage stations 577 and 1072. Figure 2-42 also shows the in-flight load limits on other floor areas and on the ramps. The capability of the ramps and floor is such that tanks and other tracked vehicles weighing up to 129,000 pounds can be loaded and transported. Vehicles whose height exceeds 142 inches will not be planned forward of FS 971 (Figure 2-41). Vehicles whose height exceeds 142 inches but less than 158 inches will be planned aft of FS 971 or must be reduced to 142 inches.

Table 2-6. C-17 Cargo Area Dimensions.

<u>USABLE CARGO AREA</u>		<u>RAMP LIMITATIONS</u>	
Length - 1,022 inches		Pallet: Height - 96 inches	
Width - 216 inches		Weight - 10,355 pounds ¹	
Height - 142 inches ²		Vehicle: Height - 122 inches	
Height - 156 inches ³		Weight - 27,000 pounds per axle	

¹Not to exceed a combined total ramp weight of 40,000 pounds.
²Fuselage stations 381 to 971.
³Fuselage stations 971 to 1164.

NOTE: Exceptions may include items configured according to TB 55-46-1 or loaded according to the aircraft loading manual.

CHAPTER 5

BASICS OF AIRCRAFT LOAD PLANNING

INTRODUCTION

This chapter shows how to carefully plan an air movement to ensure efficient use of the aircraft before loading. It concentrates on the manual air load planning method but also discusses automation. Air load planners must be proficient in manual air load planning techniques before using automated methods.

The following basic principles of load planning apply to any type of aircraft. Load planning—

- Identifies the type of aircraft needed to carry a load.
- Identifies the exact number of aircraft needed to accomplish a particular mission.
- Identifies in advance any additional required loading aids to ensure availability at load time. Aircraft ground time is minimized when the unit is prepared to load.
- Helps the unit prioritize the movement of cargo and personnel.

Many factors are considered in the load planning process. Primarily, the load planner must ensure the safe and efficient use of the aircraft. The load planner must comply with aircraft safety, weight and balance, and floor load restrictions. The load must be within an acceptable center of balance condition for takeoff, flight, and landing. The load planner must also consider the ease of loading and unloading. Improper planning can result in excessive loading or unloading time or structural failure in flight or on landing. A load properly planned and coordinated will go on the aircraft quickly, safely, and with minimum difficulty.

LOAD PLANNING CONSIDERATIONS

Some basic considerations affect the aircraft and aircraft stability. The following must be known before any load planning can begin:

- The aircraft critical leg allowable cabin load.
- The center of gravity range of the aircraft.

- The placement of the cargo in the aircraft so that the weight and balance check will not require rearranging of the cargo. Usually the heaviest items of cargo are placed in the aircraft CG area, with the lighter items forward and aft. See Table 2-2 for CB windows.
- The location of the emergency exits. Cargo should not block any passenger or emergency door.
- The location of the safety aisle. Cargo should never obstruct the required safety aisle that lets the crew move freely from the front to the rear of the aircraft.
- The cargo loading order. The cargo scheduled to be unloaded first is usually loaded last.
- The requirement for hazardous cargo marking, documentation, and placement within the aircraft. Each unit is responsible for certification of hazardous material and specific packaging requirements according to TM 38-250.

Other load planning considerations relate directly to the deploying unit: its mission and the expected scheme of operation upon arrival at destination. FM 55-12 details planning considerations and responsibilities.

TYPES OF LOADS

Aircraft loading is generally categorized into two types: concentrated loading and palletized loading.

Concentrated Loading

Concentrated loads are very large or heavy items, such as vehicles, tanks, or construction equipment. The precise station location on which the cargo is to be placed inside the aircraft must be computed. To properly place the cargo on a specified station, the cargo item must be marked with the correct center of balance. Since station

computations enter into this method of loading, it is also called station loading.

Palletized Loading

The entire aircraft load generally consists of preloaded 463L pallets, properly secured and ready for flight. The center of each pallet is its center of balance unless the pallet is marked otherwise. The 463L restraint rail system positions and secures the pallets in the aircraft. See Appendix D for more information on the 463L cargo system.

AIRCRAFT LOADING DATA

The unit load planner must be familiar with the loading rules and limitations for each aircraft. General rules that apply to all aircraft follow:

- Plan to move general bulk cargo, such as boxes or crates, on the back of cargo-carrying trucks or trailers. Stacked bulk cargo should not exceed the reduced configuration height of the cargo-carrying vehicle according to TB 55-46-1. Ensure vehicle weights used for load planning include the weight of the cargo.
- Secure all general bulk cargo with a minimum of 1/2-inch diameter rope. Hemp rope is recommended; nylon is not authorized.
- Use only forklifts rated at a lifting capacity equal to or greater than the cargo being loaded. Normally, 10K forklifts, all terrain/rough terrain (AT/RT), are used. However, some 10K forklifts with rollover protection systems (ROPS) will not fit under the tail section of the C-130 and C-141 aircraft.
- Use forklifts with a minimum tine length of 72 inches to avoid dropping or damaging the 463L pallet.
- When loading cargo in the beds of trucks or trailers, do not exceed the rated cross-country capacity of the vehicle.
- Use a minimum of 3/4-inch shoring when loading tracked vehicles with metal cleats, studs, or other gripping devices that will damage the aircraft floor. See Chapter 6 for more information on shoring.

- Do not deflate vehicle tires to achieve vehicle height clearance to fit within the aircraft loading envelope.
- Treat tires with over 100 psi as hard rubber tires; consider floor limitations.
- Do not use the book weight or item data cards for weight and balance purposes during actual airlift. Use the actual scale weight.

Another consideration when planning loads for the C-130 and C-141 is that neither has a separate troop compartment. Therefore, when planning troop movements, cargo-carrying capacity is sacrificed. The cargo load restricts the number of troops that can be carried. The following general rules apply to the use of sidewall seats when planning nonpalletized cargo:

- Cargo widths up to 80 inches - may carry troops on both sides of the cargo. Centerline load the cargo in the aircraft.
- Cargo widths of 81 inches to 96 inches - may carry troops on one side of the cargo only. For egress purposes, cargo will usually be offset to the right side of the cargo compartment.
- Cargo widths over 96 inches - no troops will be seated beside the cargo. Centerline load the cargo in the aircraft.

PRINCIPLES OF MOMENT

To understand center of balance considerations, it is necessary to understand the principles of moment. Moment is simply the product of a force (or weight) times the distance from the reference datum line. The distance used to calculate a moment is the arm, which is expressed in inches. To calculate moment, a force (or weight) and distance must be known. The distance is measured from some known point (reference point or reference datum) to the point throughout which the force acts. Moment is meaningless unless the reference point about which the moment is calculated is specified.

There are three items used in weight and balance calculations: moment, weight, and arm. The relationship of these items can be shown by arranging them in a mathematical triangle (Figure 5-1).

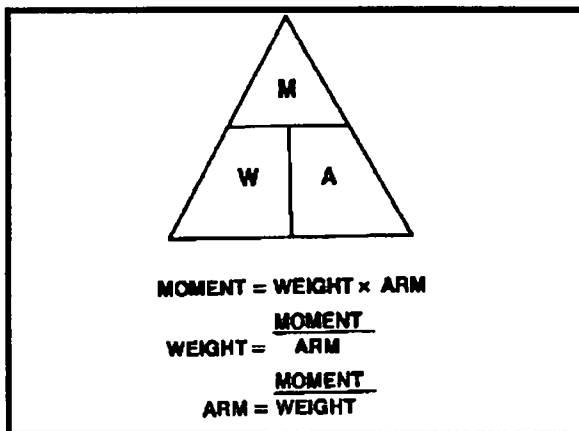


Figure 5-1. Moment-Weight-Arm Triangle.

Perhaps the simplest way to explain this is to look at a child's seesaw: A heavy board is placed across a fixed support about which the board balances (fulcrum). When there are two different size children riding the seesaw, they use their skill or intuition to make it operate properly. They do this by compensating with distance: the heavier child sits closer to the fulcrum and the lighter child sits farther away from the fulcrum.

EXAMPLE 1:

Look at Figure 5-2. A board is perfectly balanced with a 30-pound weight on one end and a 60-pound weight on the other. This example shows that the influence of weight depends directly on its distance from the fulcrum. For balance to exist, the weight must be distributed so the leverages or turning effects are the same on each side of the fulcrum. Note that the heavy weight near the fulcrum has the same effect as a lighter weight farther from the fulcrum.

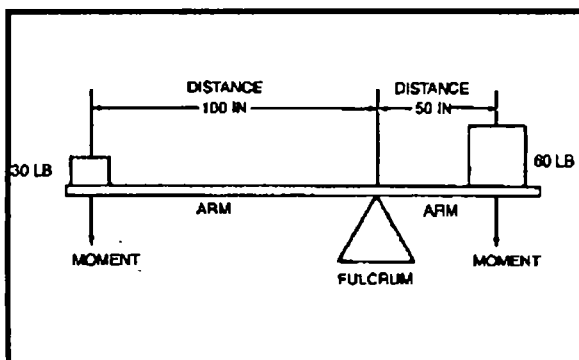


Figure 5-2. Example 1, Balanced Board.

To prove mathematically that the seesaw board is balanced, apply the formula in Figure 5-1 to determine whether or not the moments applied to each side of the fulcrum are equal.

<u>LEFT SIDE</u>	<u>RIGHT SIDE</u>
$W = 30 \text{ pounds}$	$W = 60 \text{ pounds}$
$A = 100 \text{ inches}$	$A = 50 \text{ inches}$
$M = W \times A$	$M = W \times A$
$= 30 \times 100$	$= 60 \times 50$
$= 3,000 \text{ inch-pounds}$	$= 3,000 \text{ inch-pounds}$

Substituting the values from the above example into the formula shows that each side has a moment of 3,000, and the seesaw board is perfectly balanced.

EXAMPLE 2:

If the fulcrum is unknown with the same seesaw board and the same weights as in Example 1, the problem is to determine the location of the fulcrum, or the CB. To find the fulcrum, apply the same formula described in Example 1, but first measure some distances (arm) to find the appropriate moment for each weight. To measure the distance, a specific known starting or reference point is needed. These measurements may be made from any point, but in this example, the left end of the seesaw board will be the reference point or reference datum (Figure 5-3).

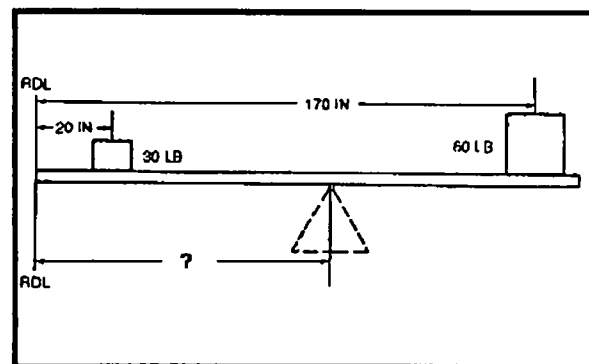


Figure 5-3. Example 2, Unknown Balance Point.

Assume the distance for each of the weights on the seesaw board from the RD line measured 20 and 170 inches respectively. Note that the distances are measured from the RD to the center of

mass or CB of each of the weights. Using the same formula again, compute the moment:

Weight x Arm = Moment

$$30 \times 20 = 600 \text{ inch-pounds}$$

$$\frac{60 \times 170 = 10,200 \text{ inch-pounds}}{90}$$

$$10,800 \text{ inch-pounds}$$

Add the weights and the moments (inch-pounds) as shown above. Now, to find the distance to the center of balance (fulcrum) in this example, divide the total moment by total weight.

$$\frac{\text{Total Moment}}{\text{Total Weight}} = \text{Arm or } \frac{10,800}{90} = 120 \text{ inches}$$

Therefore, the center of balance (fulcrum) of this seesaw board is 120 inches from the RD line (Figure 5-4).

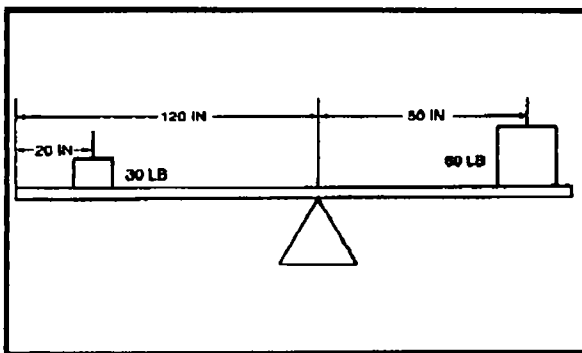


Figure 5-4. Example 2, Balanced Board.

Again to prove mathematically that each side of the seesaw board is subjected to the same moment, and therefore is balanced, calculate as follows:

LEFT SIDE	RIGHT SIDE
A = 120 - 20	A = 170 - 120
= 100	= 50
M = W x A	M = W x A
= 30 x 100	= 60 x 50
= 3,000 inch-pounds	= 3,000 inch-pounds

Since the same moment or leverage (3,000 inch-pounds) is applied to each side, the seesaw board is balanced.

LOAD CENTER OF BALANCE

In some older publications, the term center of gravity or CG is widely used with aircraft loads (cargo). This term is the same as load or cargo center of balance. Since balance of the aircraft is mainly affected by weight variations along the longitudinal axis of the cargo inside the aircraft, the term center of balance more appropriately refers to the balance point of items of cargo or equipment that go into the aircraft.

For general cargo center of balance computation and vehicle center of balance computation, refer to Appendix G of FM 55-12.

For load center of balance computation, decide what goes on each aircraft; then compute the total load weight and balance to ensure that the load is within aircraft limits. To do this, know the —

- Weight of each vehicle or piece of equipment.
- Fuselage station CB of each vehicle or piece of equipment as it is located within an aircraft.
- Total cargo center of balance limitations range of the aircraft.

The formula to find the load CB is the same as described in the previous two examples. To find the arm, the final CB of the loaded aircraft, add all the weights and moments of the cargo. Then divide the total moment by the total weight to get the final CB (Figure 5-1). If that CB is within limits (CB limitation range) for that aircraft, the load is acceptable. If the CB is not within CB limits of the aircraft, then move or resequence some of the cargo items and recalculate.

EXAMPLE:

A C-141B load with the weights and fuselage stations shown in Table 5-1 has been developed.

The final CB of this aircraft load is 940. The cargo load center of balance limits (floating window) is in Table 2-2. The CB limits of a C-141B with a 50,000-pound cargo load is from 880 to 950. So this load is acceptable and will not endanger the aircraft.

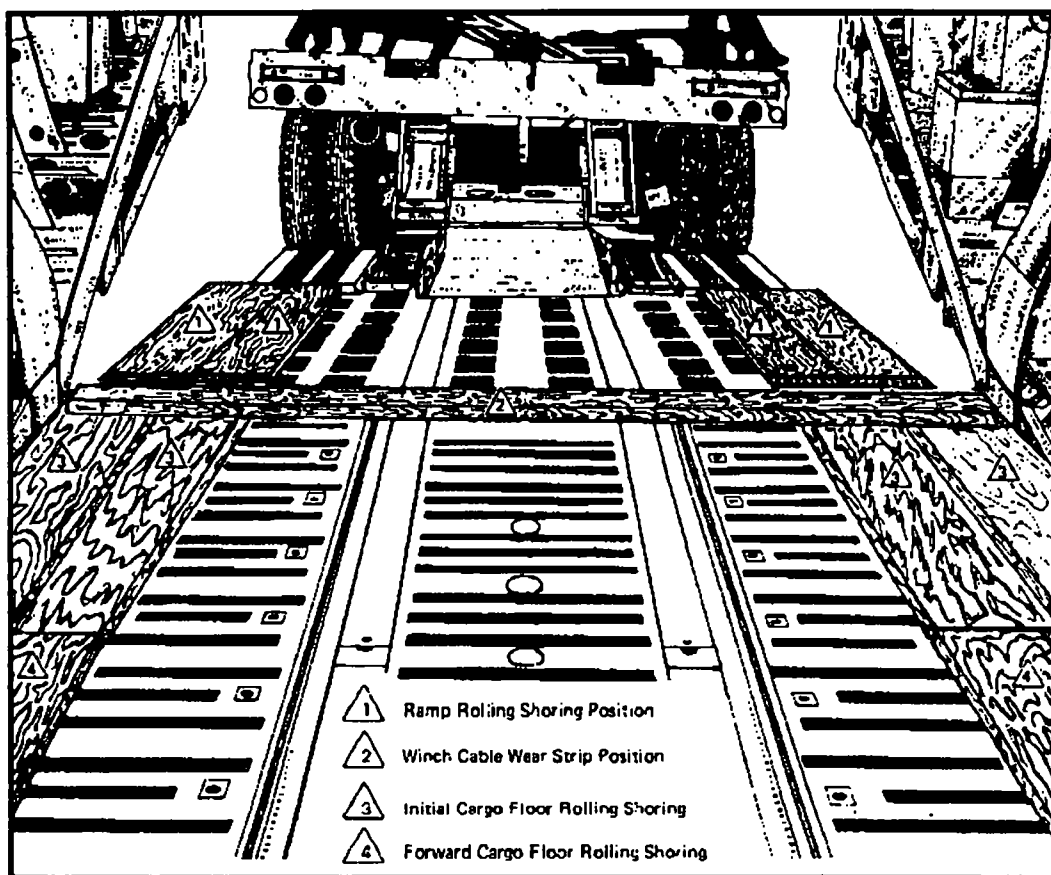


Figure 6-3. Example of Rolling Shoring.

In all cases, the minimum thickness is $\frac{3}{4}$ inch. For cleated vehicles such as bulldozers, the requirement will be $\frac{3}{4}$ inch plus the length of the cleat. Movement personnel should always plan on rolling and parking shoring for tracked vehicles, even those with new rubber pads. That tracked vehicle may deploy with new track pads, but it will probably not redeploy with new ones. Any vehicle or piece of equipment that requires rolling shoring to load aboard the aircraft will also require parking shoring.

Parking Shoring

Use parking shoring to protect the aircraft floor from damage during flight (Figure 6-4). Any vehicle requiring rolling shoring also requires parking shoring. Each aircraft has specific floor weight limitations that apply to wheeled and non-wheeled items of cargo. If the vehicle exceeds these weight limitations, it must have parking shoring before it may be transported by air. There is no need to learn the mathematical process used to calculate shoring requirements. But some

general considerations regarding parking shoring should be remembered when planning an airlift movement:

- The minimum thickness of parking shoring is $\frac{3}{4}$ inch.
- Use parking shoring to protect the aircraft floor or aircraft loading ramps from concentrated contact or metal-to-metal contact, such as steel wheels and trailer tongue supports and wheels.
- Most pneumatic tires do not require parking shoring. Those that do are usually very narrow or heavy (over 5,000 pounds).
- Always use parking shoring when rolling shoring is required.
- Always use parking shoring on 463L pallets when the items have sharp edges or protrusions that could damage the pallet's aluminum surface. Contact the affiliated AMC ALCS for guidance about specific vehicles or aircraft limitations.

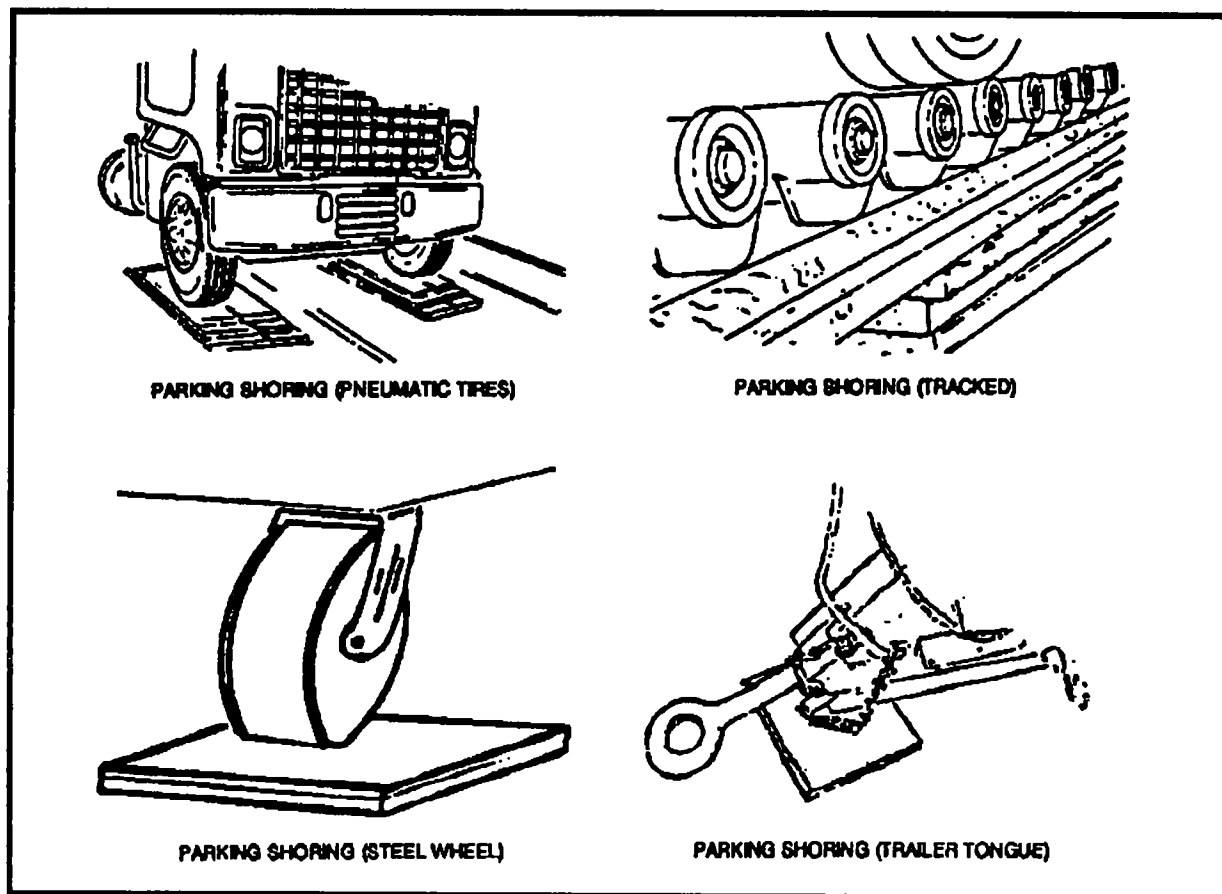


Figure 6-4. Examples of Parking Shoring.

Sleeper Shoring

Use sleeper shoring under the frame or axle of any special-purpose vehicle, such as a forklift, scoop loader, or grader, that weighs over 20,000 pounds and has tires that are not designed for highway travel. Depending on the type of vehicle, sleeper shoring is placed between the aircraft floor and a structured part of the vehicle, such as the frame or axle (Figure 6-5). This type of shoring prevents the vehicle from bouncing up and down and possibly pulling the tie-down rings out of the aircraft floor. An aircraft encountering turbulence during flight may cause these vehicles to oscillate and place extreme forces on the tie-down devices and tie-down points that would exceed their rated capacities.

Special Shoring

Special shoring consists of approach shoring, ramp pedestal shoring, bridge shoring, and other nonspecific types of shoring.

Approach shoring has a specific application. Use approach shoring to decrease the approach angle of the aircraft loading ramps (Figure 6-6) because some items of cargo will strike the aircraft or ground during loading and unloading operations. Although there is no standard method to calculate when and how much approach shoring to use, most helicopters and many long vehicles that have limited ground clearance, such as lowboys, will require varying amounts of approach shoring. Plan to transport any required approach shoring aboard the same aircraft as the item that requires the shoring.

Use ramp pedestal shoring with approach shoring to adjust the height of the ramp to match requirements of the approach shoring.

Use bridge shoring to take advantage of the greater strength of the vehicle treadways of the aircraft cargo floor. It allows heavy cargo to be positioned between the treadways without

All dimensions (thickness, length, and width) for required shoring must be actual size. Commercial-size lumber may not satisfy this requirement. For example, a 1 5/8- by 3 5/8-inch piece of lumber will not satisfy a 2- by 4-inch requirement.

Inspect shoring before use to ensure that it is clean, sound, free of nails, and fit for its intended use. Any defect in the lumber reduces its strength. Split lumber will not transfer the weight of the cargo past the split. The aircraft loadmaster may reject dirty, badly warped lumber, which will delay the loading of the aircraft.

Shoring requirements must be identified and obtained as soon as possible to ensure unit readiness. Units should plan on storing shoring and should be prepared to adjust unit needs as equipment changes.

TRANSPORT OF SHORING

When shoring is required to load cargo, it will also be needed to unload. If shoring is not available at the destination, then the shoring must be transported with the load. Include the weight of the shoring with the weight of the cargo to accurately determine the aircraft center of gravity. For tracked vehicles, simply load the lumber on top of the vehicle while it is being weighed. The weight of the shoring will not affect the vehicle center of balance. For rough terrain forklifts or other pieces of equipment that require sleeper shoring, weigh the shoring separately and add the weight to the vehicle weight. For trailers or other pieces of equipment that only require shoring under the tongue, do not worry about the weight, but always make sure adequate shoring is available.

A 3/4-inch thick by 4-foot wide by 8-foot long plywood panel weighs about 65 pounds. A 2-inch thick by 12-inch wide by 12-foot long plank weighs about 75 pounds.

SHORING REQUIREMENTS

To find out how much shoring to use, find out how many pounds per square inch of pressure the cargo will put on the aircraft floor. All aircraft have a pound-per-square-inch limitation, so the purpose of the calculations is to find the minimum amount of shoring necessary to do the job. Too much shoring may make the cargo too heavy to fly;

too little shoring may allow the weight of the cargo to damage the aircraft.

To find the pressure rating of a piece of cargo, use two formulas: one to find how many square inches of the cargo will actually contact the cargo floor (area) and the second to find the actual pressure or weight of the piece of cargo.

For example, you have a trailer tongue support leg with a contact length of 3 inches and a contact width of 2 inches. The trailer tongue support leg will rest on the aircraft floor. The support leg weighs 325 pounds. Multiply the length by the width to get the area, in this case, 6 square inches.

$$L \times W = A \quad 3 \times 2 = 6 \text{ square inches}$$

To find the psi of that trailer support leg, divide the support leg weight by the area. For this example, it is 54.2 psi.

$$\frac{W}{A} = \text{psi} \quad \frac{325}{6} = 54.2 \text{ psi}$$

If the aircraft floor limit is 25 pounds per square inch, then place shoring under the support leg to spread the load. A 1/2-inch-thick piece of shoring will not be enough, so put a 3/4-inch-thick board under the support leg.

Shoring is not effective under its entire length, but only at a 45-degree angle from the edge of the piece of cargo. So 3/4-inch-thick shoring will spread the load only 3/4 inch on each side of the cargo. This results in spreading the load over an area of 4.5 by 3.5 inches.

This reduces the psi to 20.7. Therefore, a 3/4-inch-thick board measuring 4.5 by 3.5 inches under the trailer support leg safely places it on the aircraft floor.

$$\frac{325}{15.75} = 20.63 \text{ or } 20.7 \text{ psi}$$

NOTE: When rounding figures, always round pressure figures up to the next higher tenth of an inch. For example, 2.69 psi would round up to 2.7 psi. Always round area figures down to the next lower tenth (7.58 will be 7.5 square inches). This provides an increased safety factor. The psi is higher than it actually is, and the area is smaller than it actually is.

FORMULAS

The basic formulas for computing area and pounds of pressure for various shaped objects are in Figure 6-8.

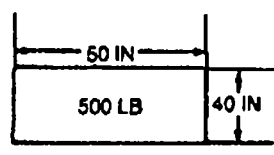
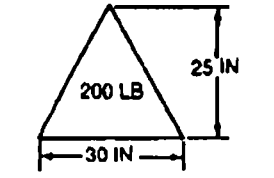
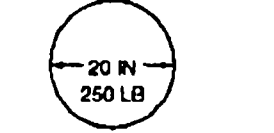
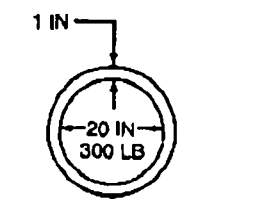
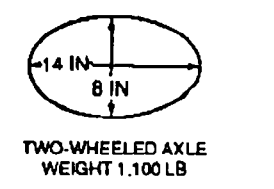
RECTANGLE	Weight divided by length times width. $\frac{\text{Weight}}{\text{Length} \times \text{Width}} = \text{Pressure} \quad \frac{500}{50 \times 40} = 0.25 \text{ lb/in}^2$	
TRIANGLE	Weight divided by one half the base of triangle times the height. $\frac{\text{Weight}}{\frac{1}{2} \text{ Base} \times \text{Height}} = \text{Pressure} \quad \frac{200}{15 \times 25} = 0.53 \text{ or } 0.6 \text{ lb/in}^2$	
CIRCLE	Weight divided by diameter squared times 0.785. $\frac{\text{Weight}}{\text{Diameter}^2 \times 0.785} = \text{Pressure} \quad \frac{250}{20^2 \times 0.785} = 0.79 \text{ or } 0.8 \text{ lb/in}^2$	
CIRCULAR BARREL WITH RIM	Weight divided by outside diameter squared minus inside diameter squared times 0.785. $\frac{\text{Weight}}{\text{Outside Diameter}^2 - \text{Inside Diameter}^2 \times 0.785} = \text{Pressure}$ $\frac{300}{22^2 - 20^2 \times 0.785} = 4.54 \text{ or } 4.6 \text{ lb/in}^2$	
TIRE PAD	Weight of axle divided by length times width of tire pad times 0.785 times number of tires on the axle. (Each axle of a vehicle must be computed separately.) $\frac{\text{Weight of Axle}}{\text{Length} \times \text{Width} \times 0.785 \times \text{No. Tires on Axle}} = \text{lb/in}^2$ $\frac{1,100}{14 \times 8 \times 0.785 \times 2} = 6.25 \text{ or } 6.3 \text{ lb/in}^2$	 TWO-WHEELED AXLE WEIGHT 1,100 LB

Figure 6-8. Formulas.

CHAPTER 7

CARGO RESTRAINT

INTRODUCTION

This chapter provides guidelines for restraining cargo on military and civilian aircraft. Cargo is restrained (tied down) in an aircraft so that it remains stationary in the cargo compartment when the aircraft is subjected to rough air, vibration, acceleration, deceleration, and rough landings. The greatest force exerted on the cargo is usually the forward movement encountered when the aircraft slows rapidly on landing. When the pilot applies the aircraft brakes on landing, the cargo tends to keep moving at a higher speed. The cargo is also restrained in proportion to its weight, so that it will not shift when the aircraft turns, takes off, lands, or encounters other forces while flying. Tie-down equipment is aboard the aircraft to be used to restrain cargo.

PRINCIPLES OF CARGO RESTRAINT

Cargo loaded in an aircraft is restrained so that it will not shift during any condition the aircraft experiences in flight. Basic principles of restraint apply to tying down cargo. Although the details vary for different kinds of cargo, the basic principles of restraint do not change. The basic principles follow:

- Tie down cargo to prevent movement in all directions.
- Install tie-down devices to provide adequate restraint without overstressing the tie-down fitting or damaging the cargo.
- Ensure the tie-down leads directly from the tie-down fitting on the aircraft floor to the load being restrained.
- Attach tie-down devices in symmetrical pairs. Unsymmetrical tie-downs cause uneven load distribution and could result in tie-down failure (Figure 7-1).
- Ensure tie-down pairs in a given direction are equal in type and length. (Any material subjected to a tension load stretches to a given percentage of its length. Therefore,

the greater the length, the greater the potential amount of stretch. If two tie-downs of the same type and capacity restrain a load in a given direction and one tie is longer than the other, the longer tie has a greater stretch potential. The shorter tie assumes the majority of any load that may develop. If as a result the shorter tie is overstressed and fails, the longer tie would be subjected to the full load and it too would probably fail.)

- Use the nylon CGU-1/B strap on cargo that may be damaged by chains, such as fragile/crushable cargo or baggage.

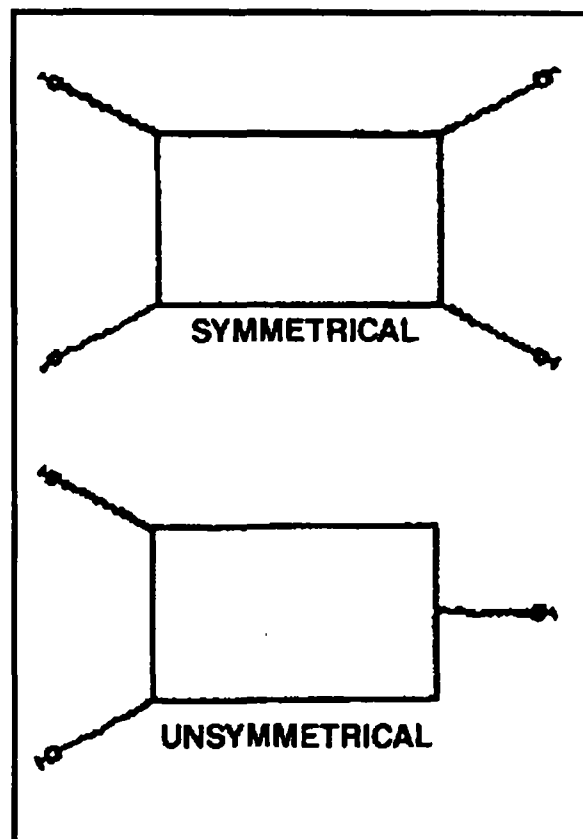


Figure 7-1. Symmetrical and Unsymmetrical Pairing.

RESTRAINT CRITERIA

Restraint criteria for aircraft cargo are based on the weight of the cargo and the forces imposed on it due to changes in motion (changing direction, slowing down, or speeding up). The force increases as the rate of change in motion increases.

The primary restraint criterion is the minimum amount of restraint needed to keep cargo from moving in a specific direction. A numerical factor (G factor) called restraint safety factor or load factor has been determined for cargo aircraft. This figure determines the number of tie-down devices to use.

Imagine a passenger traveling in a car at 50 mph. The driver jams on the brakes for a sudden stop. What happens to the passenger when the brakes are applied? The same thing happens to the cargo in an aircraft. A sudden change in direction or speed of the aircraft moves the cargo in the same manner. The change in motion is called the outside force. The amount of outside force to which a unit of cargo may be subjected is called the load or E.G. factor. Multiplying the weight of a unit of cargo by the E.G. factor results in the amount of required restraint for that unit of cargo:

$$\text{Weight} \times \text{E.G. Factor} = \text{Required Restraint}$$

For example, a unit of cargo weighing 5,000 pounds is to be restrained from moving forward. The forward E.G. factor for the aircraft is 3. Use the formula to determine the total load to be restrained: cargo weight (5,000 pounds) times E.G. factor (3) equals the weight to be restrained against forward movement (15,000 pounds).

DIRECTION OF RESTRAINT

The direction in which the cargo would move if it were not restrained identifies the restraint criteria applied to the cargo to prevent its movement. Forward restraint keeps cargo from moving forward in the aircraft; aft restraint, from moving backward; lateral restraint, from moving to either side; and vertical restraint, from moving up off the aircraft floor. The aircraft floor is downward restraint. Use the restraint criteria in Table 7-1.

Table 7-1. Restraint Criteria.

DIRECTION OF RESTRAINT	E.G. FACTOR	
	C-130, C-141, C-5, C-17	KC-10
Forward	3.0 g's	1.5 g's ¹ 9.0 g's ²
Aft	1.5 g's	1.5 g's
Lateral (left and right)	1.5 g's	1.5 g's
Vertical	2.0 g's	2.0 g's

¹With the KC-10 cargo barrier net installed.
²Without the KC-10 cargo barrier net.

TIE-DOWN DEVICES

Three tie-down devices are used to secure cargo in the aircraft:

- The MB-1 tie-down device has a 10,000-pound rated capacity.
- The MB-2 tie-down device has a 25,000-pound rated capacity.
- The CGU-1/B tie-down device has a 5,000-pound rated capacity. This device is commonly called a 5,000-pound strap.

The MB-1 and MB-2 devices (Figure 7-2) are similar in looks, use, and the way they operate. The only significant difference is their load capacities and size.

The CGU-1/B tie-down device (Figure 7-3) is a 20-foot nylon web strap with two metal hooks attached. One hook is stationary at one end of the strap, while the other hook has a ratchet device and can be moved over the length of the strap. The ratchet tightens the device when it is being used.

Similar methods are used to restrain all types of cargo. The details for restraining each cargo item vary with its bulk, weight, configuration, and location in the aircraft and whether it is equipped with tie-down provisions. These variations make restraining each piece of cargo a separate problem.

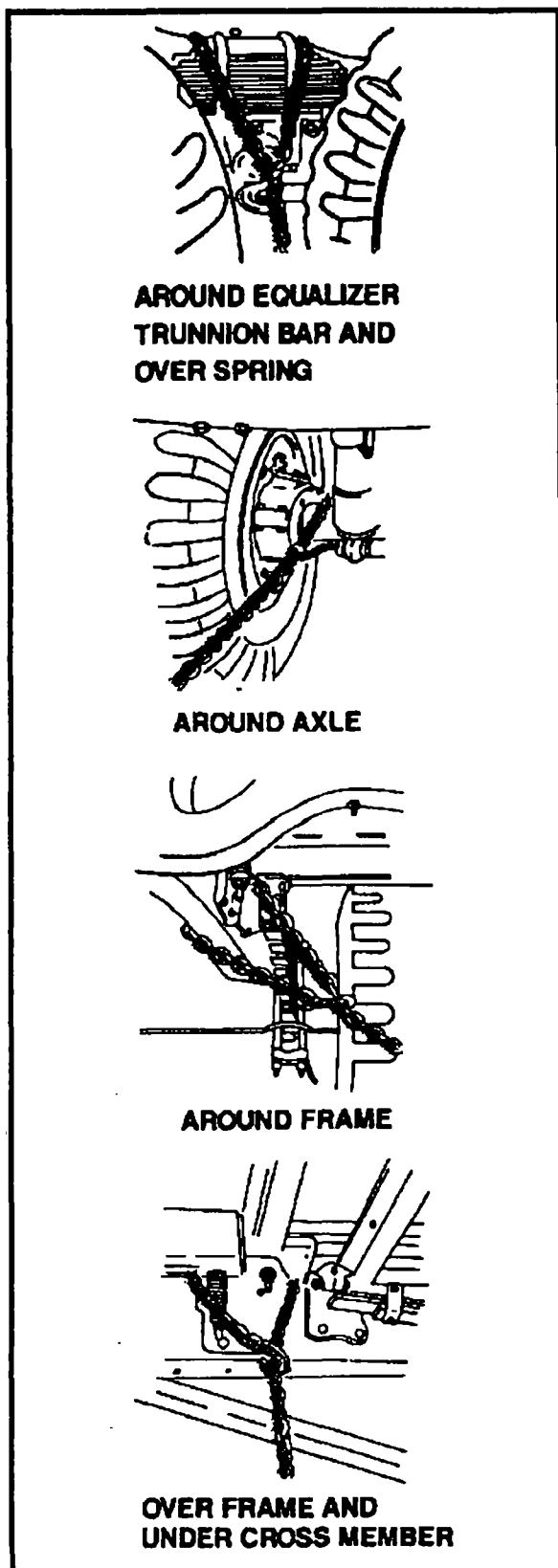


Figure 7-4. Vehicle Tie-Downs.

To determine the number of tie-down devices required to properly secure any given item of cargo, know how each of the following influences cargo tie-down:

- Weight of cargo.
- Restraint factor for each direction (g force).
- Floor and plane angles of devices when attached.
- Rated strength of tie-down devices to be used.
- Strength of tie-down fittings on aircraft floor and cargo item.

To find the force that must be restrained, use the first two factors: weight of the cargo and the restraint factor. Written in formula form, it is—

$$\text{E.G.} \times W = F$$

Where:

Restraint factor = E.G.

Weight of the cargo = W

Force to be restrained = F

REQUIRED NUMBER OF TIE-DOWN DEVICES

The two methods for determining the number of tie-down devices needed to secure a load in an aircraft are the percentage restraint chart and the percent of angle of tie. The percentage restraint chart is a quick method for advance estimating of the number of tie-down devices required. This method is not as precise as the percent of angle of tie. The percent of angle of tie is the most precise method to find the exact restraint achieved. It uses several formulas that require knowing the exact angle of tie and cannot be used for advance planning.

Percentage Restraint Chart

The percent of angle of tie can be determined by using the percentage restraint chart (Figure 7-5). Floor angle degrees are in the top horizontal row, and plane angle degrees are in the left vertical row. To find the percent of effectiveness of a 30/30-degree angle, first read the floor angle across the top of the chart (30 degrees). The figure directly below the floor angle degree is the percentage of rated strength for vertical (up)

restraint. Next, read the plane angle down the left side of the chart (30 degrees). Next to the plane angle are LON (longitudinal) and LAT (lateral), the directions in which the tie-down will be effective. Read across the table until the 30-degree plane angle line intersects the 30-degree floor angle column.

The numbers at this intersection represent the restraint provided by a restraint device applied at a 30/30-degree angle. These numbers express a percentage of the maximum rated strength of a tie-down device. A device rated at 10,000 pounds would provide 7,490 pounds of longitudinal

restraint, 4,330 pounds of lateral restraint, and 5,000 pounds of vertical restraint.

The formulas will help determine how many of each type of tie-down device should be used for each piece of cargo. Do not mix the types of devices. If the formulas say to use MB-2 devices, do not substitute a lower-rated device or the restraint will be insufficient.

Remember also to use the devices in pairs. If the answer is not an exact even number, always round up to the next highest even number when using chains. For example, if the figures came out to 2.2 devices, apply 4.

NOTE: 1. Angles across the top are those formed between the tie-down device and the cabin floor.
2. Angles down the side are those formed between the tie-down device and the longitudinal axis of the aircraft.
* Vertical restraint is related only to the angle between the tie-down device and the cabin floor. The lateral angle has no bearing on it.
** The "best compromise" position.

		FLOOR ANGLE - DEGREES																	
		9°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	
PLAN ANGLE - DEGREES	VERTICAL	8.7	17.4	25.9	34.2	42.3	50.0	57.4	64.3	70.7	76.6	81.9	86.6	90.6	93.9	96.6	98.5	99.6	
	5°	LON	99.2	98.1	95.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3	8.7
	LAT	0.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5	0.8	
	10°	LON	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1	8.6
	LAT	17.3	17.1	16.9	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0	1.5	
	15°	LON	95.2	95.2	93.3	90.6	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8	8.4
	LAT	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5	2.3	
	20°	LON	93.6	92.6	90.6	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6	8.2
	LAT	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.8	18.6	17.1	14.5	11.7	8.9	5.9	2.9	
	25°	LON	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9
	LAT	42.1	41.7	40.9	39.8	38.5	36.8	34.8	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7	
	30°	LON	86.3	85.3	83.7	81.4	78.5	**74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.8	29.6	22.4	15.1	7.5
	LAT	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4	
	35°	LON	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1
	LAT	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9	
	40°	LON	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3	6.7
	LAT	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6	
	45°	LON	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
	LAT	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2	
50°	LON	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6	
LAT	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3	6.7		
55°	LON	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	35.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9	
LAT	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1		
60°	LON	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4	
LAT	85.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	56.7	49.7	43.3	36.8	29.6	22.4	15.1	7.5		
65°	LON	42.1	41.7	40.9	39.8	38.5	36.8	34.8	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7	
LON	80.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9		
70°	LON	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.8	19.8	17.1	14.5	11.7	8.9	5.9	2.9	
LAT	93.6			88.4	85.2	81.4	76.9	72.0	66.5				47.0	39.8	32.1	24.3	16.6	8.2	
LON							21.2	19.8							6.7	4.5			

Figure 7-5. Percentage Restraint Chart.

If a cargo item weighs 8,000 pounds, its restraint must withstand a 3 E.G. forward force using MB-1 tie-down devices attached on 30-degree floor and plane angles. Attached at these angles, the effective holding strength of the MB-1 is 74.9 percent of its rated strength of 10,000 pounds.

The formula for determining the required number of devices is —

$$\frac{\text{Restraint Factor} \times \text{Weight of Cargo}}{\text{Strength of Device} \times \text{Percent of Angle of Tie-Down}}$$

$$= \frac{\text{Force to be Restrained}}{\text{Effective Holding Strength of Device}}$$

= Total Number of Devices Required, or

$$\frac{G \times W}{R \times P} = \frac{F}{S} = N$$

Substituting numbers, the calculation is —

$$\frac{3G \times 8,000 \text{ pounds}}{10,000 \text{ pounds} \times 75 \text{ percent}} = \frac{24,000}{7,500} = 3.2 \text{ or } 4 \text{ devices needed}$$

Multiplying the rated strength of the device by the percent of angles at which it is attached equals the effective holding strength of the tie-down device. Written as a formula, it is —

$$R \times P = S$$

Where:

Rated strength = R

Percent of angle of tie-down = P

Effective strength of each device = S

Combine the results of the first two formulas to find how many devices to use for each piece of cargo:

$$\frac{F}{S} = N$$

Where:

Force to be restrained = F

Effective strength of each device = S

Number of devices required = N

The product of this formula gives only the number of devices required for one direction of restraint. Use the same process for aft, lateral, and vertical restraint as well. Displaying all the calculations in table form makes the total amount of calculation easier (Figure 7-6). The example in Figure 7-6 represents a 45/45-degree angle.

To use the chart, follow the order of calculations as they are listed along the top. Blocks 1 and 2 (Direction of Restraint and Restraint Factor) always contain the information shown in Figure 7-6. The restraint factors for Air Force aircraft have been determined through scientific analysis and cannot be changed by the unit. The unit must supply the information in the rest of the blocks.

Block 3: Cargo weight is the total weight of the vehicle or cargo. It includes any cargo in the vehicles, vehicle fuel, shoring, and any other additions. It does not include the weight of the driver or crew of any vehicle.

Block 4: Force to be restrained is the answer when Block 2 is multiplied by Block 3.

Block 5: Effective strength of device is found using the percentage restraint chart (Figure 7-5). Determine the angle of tie to be used, read right for plane angle and down for floor angle, and find the percent of effectiveness for the device at this angle. Multiply the percent of effectiveness by the rated strength to get the effective strength of the device. Enter the result in Block 5.

Block 6: Devices needed is the answer when Block 4 is divided by Block 5. If the answer is a fraction, always round up to the next highest even number. (This number is always even because the tie-down devices are used in pairs.)

Block 7: Restraint achieved is the answer when Block 5 is multiplied by Block 6. This is a cross-check to ensure that enough restraint is being used. If the figure in Block 7 is lower than that in Block 4, more devices must be added.

NOTE: The devices used versus the devices needed could be different from the figure in Block 6. When tie-down devices are applied at an angle, they will provide restraint in more than one direction. The same chains used for fore and aft restraint will also provide vertical and lateral restraint. Only if the fore and aft restraint is insufficient for vertical and lateral restraint will more devices have to be added.

Percent of Angle of Tie

It is not always possible to apply tie-down devices at a known or desired angle because of cargo configuration or interference by other cargo. After tie-down devices have been applied to a cargo item, their effective restraining strength is found by measuring the lengths of the chains. The percent of angle of tie is used to determine if enough restraint has been applied to a piece of cargo after it is loaded and restrained in the aircraft.

Tie-downs attached to a load usually provide restraint in three measurable directions: on a vertical plane, a lateral plane, and a longitudinal plane. The vertical angle is the angle between the chain from the attachment point or tie-down fitting (Figure 7-7, A and B) and the aircraft floor. The lateral plane angle (Figure 7-7, A and C) is the angle between the chain and a line which runs across the cargo compartment through the attachment point. The longitudinal plane angle (Figure 7-7, A and D) is the angle between

the chain and a line which runs fore and aft in the cargo compartment through the attachment point.

NOTE: For ease of illustration, Figure 7-7 shows only one tie-down device. However, tie-down devices must be attached in pairs, with each device having the same angles. Attaching a pair of tie-down devices to the opposite ends of the cargo item will provide restraint against movement in all directions.

When a tie-down device is attached at an angle, its effectiveness is reduced; the greater the angle, the greater the reduction.

EXAMPLE 1:

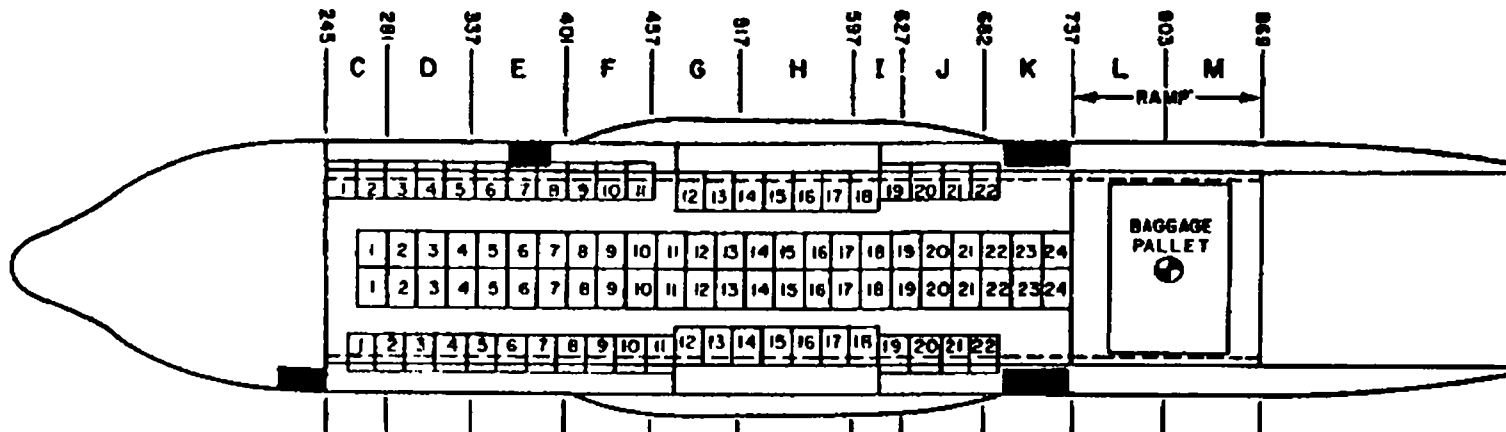
Use a 25,000-pound-capacity MB-2 tie-down device applied to a cargo item. Figure 7-7 shows a method to determine effective restraint for cargo tie-down. As shown, determine tie-down ratios by dividing tie-down chain length into the effective length for the direction in which restraint is required. Then multiply this ratio by the strength of the tie-down chain or attachment point, whichever is less, to find the restraint received from the tie-down pattern used.

1. Measure the length of the tie-down chain (A) from the tie-down fitting to the attachment point on the cargo: 50 inches.
2. Measure the effective vertical length (B) from the attachment point on the cargo to a point directly beneath it on the cargo floor: 25 inches.

1 Direction of Restraint	2 Restraint Factor	3 Cargo Weight	4 Force to be Restrained	5 Effective Strength of Device	6 Devices Needed	7 Restraint Achieved
Fwd	3.0	8,000	24,000	7,490	4	29,960
Aft	1.5	8,000	12,000	7,490	2	14,980
Lat	1.5	8,000	12,000	4,330	4	17,320
Vert	2.0	8,000	16,000	5,000	4	20,000

Figure 7-6. Restraint Calculations Chart.

Figure A-3. C-130 Configuration AE-2.



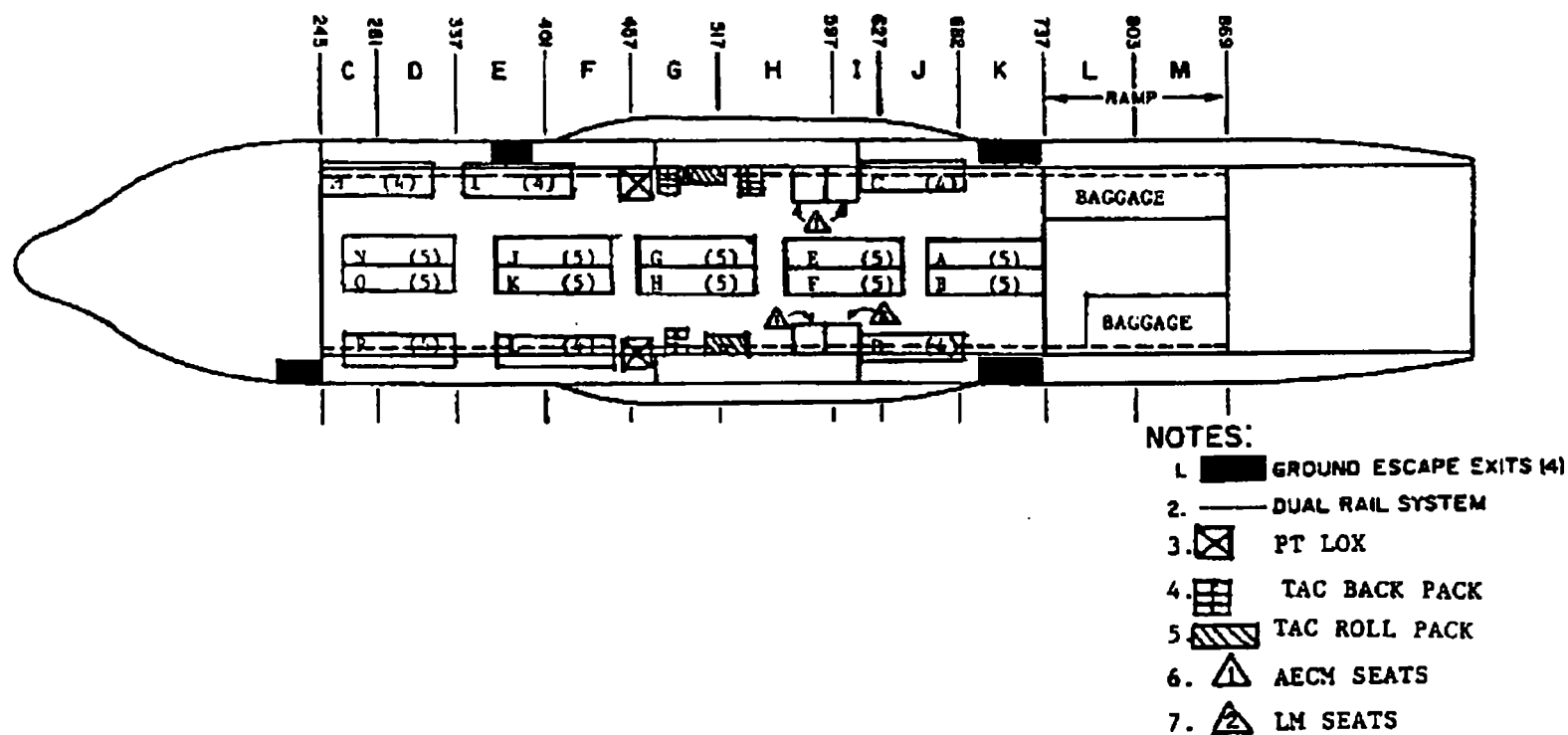
NOTES:

1.  GROUND ESCAPE EXITS (4)
2.  DUAL RAIL SYSTEM

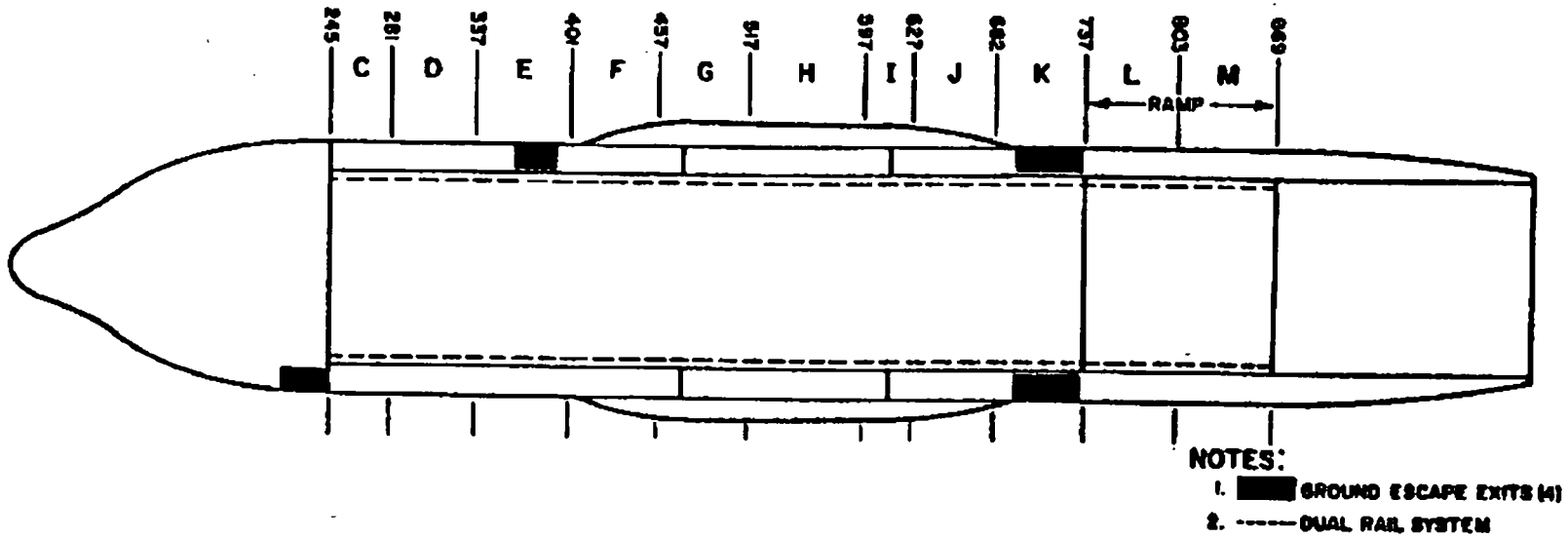
1. Ninety-two sidewall and center aisle seats--seat belts on 20-inch centers--90 seats offered. Overwater flights are limited to a maximum of 80 total personnel, including crew. For overwater flights eliminate outboard wheel well seats.
2. Seats are numbered for identification and will be referred to as sidewall seat 1 left/seat 1 right or center aisle seat 1 left/seat 1 right.
3. Cargo floor roller conveyors are removed and stowed under center aisle seats (no more than two high).
4. Time to configure is two persons, two hours.

C-130 CONFIGURATIONS

Figure A-4. C-130 Configuration C-1.



1. This AE configuration provides 70-74 litter spaces and eight wheel well seats.
2. Wheel well seats will be installed and hooked up to the seat-back support bar. Final seat installation will be completed by AECMs.
3. Time to configure is two persons, two hours.



1. Cargo on floor and/or rolling items.
2. Roller conveyors stowed on top of outboard rails.
3. C-1 seating is as required depending on amount and type of cargo being airlifted.

Figure A-5. C-130 Configuration C-2.

Figure A-6. C-130 Configuration CP-1.

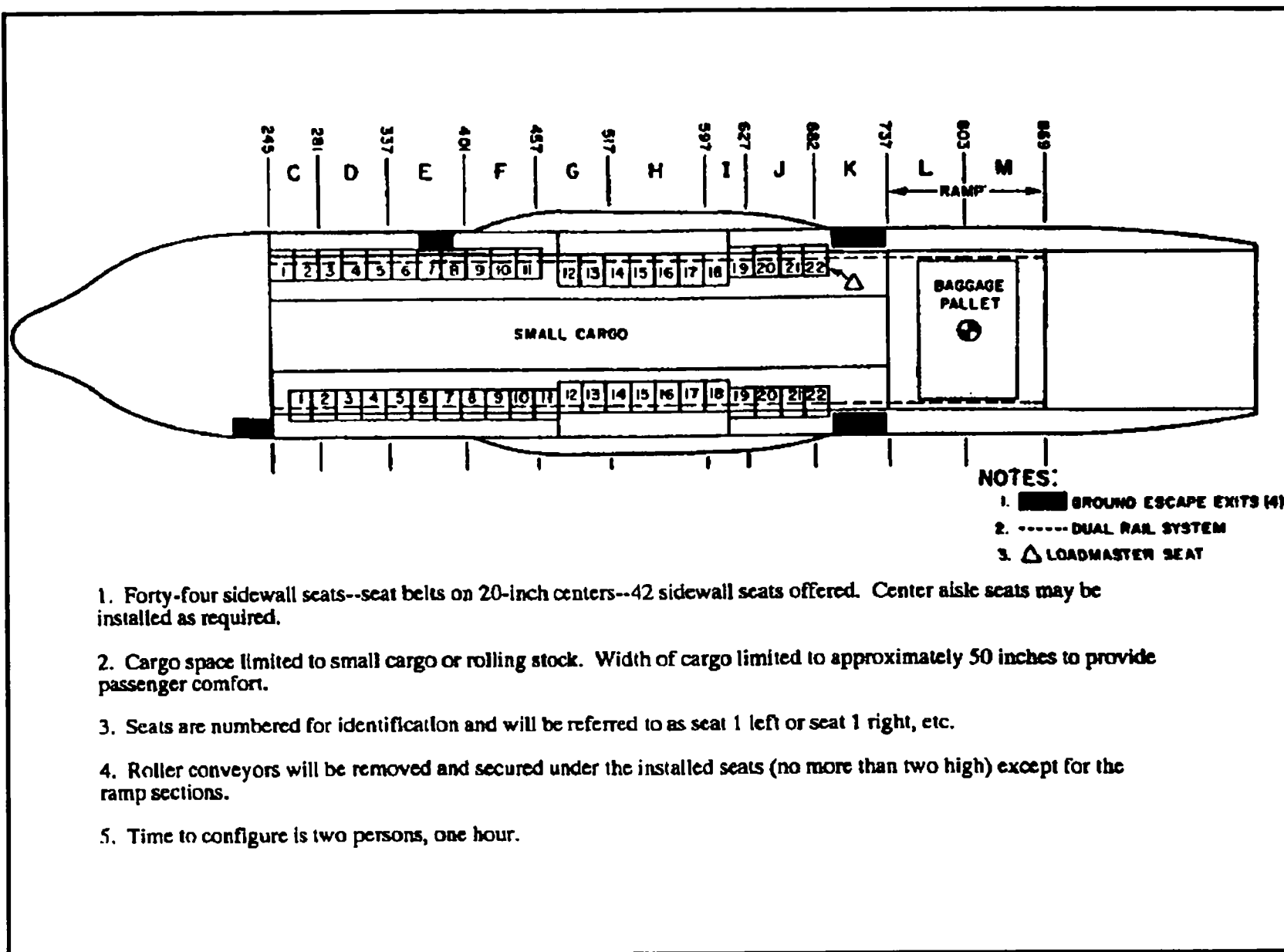
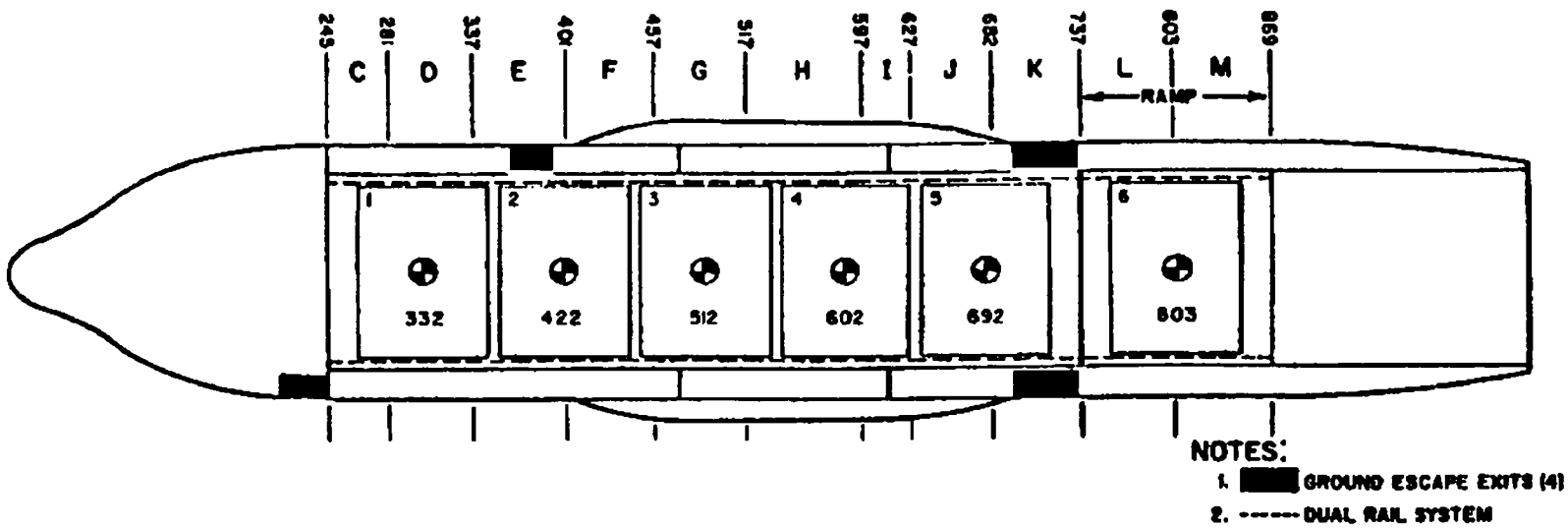
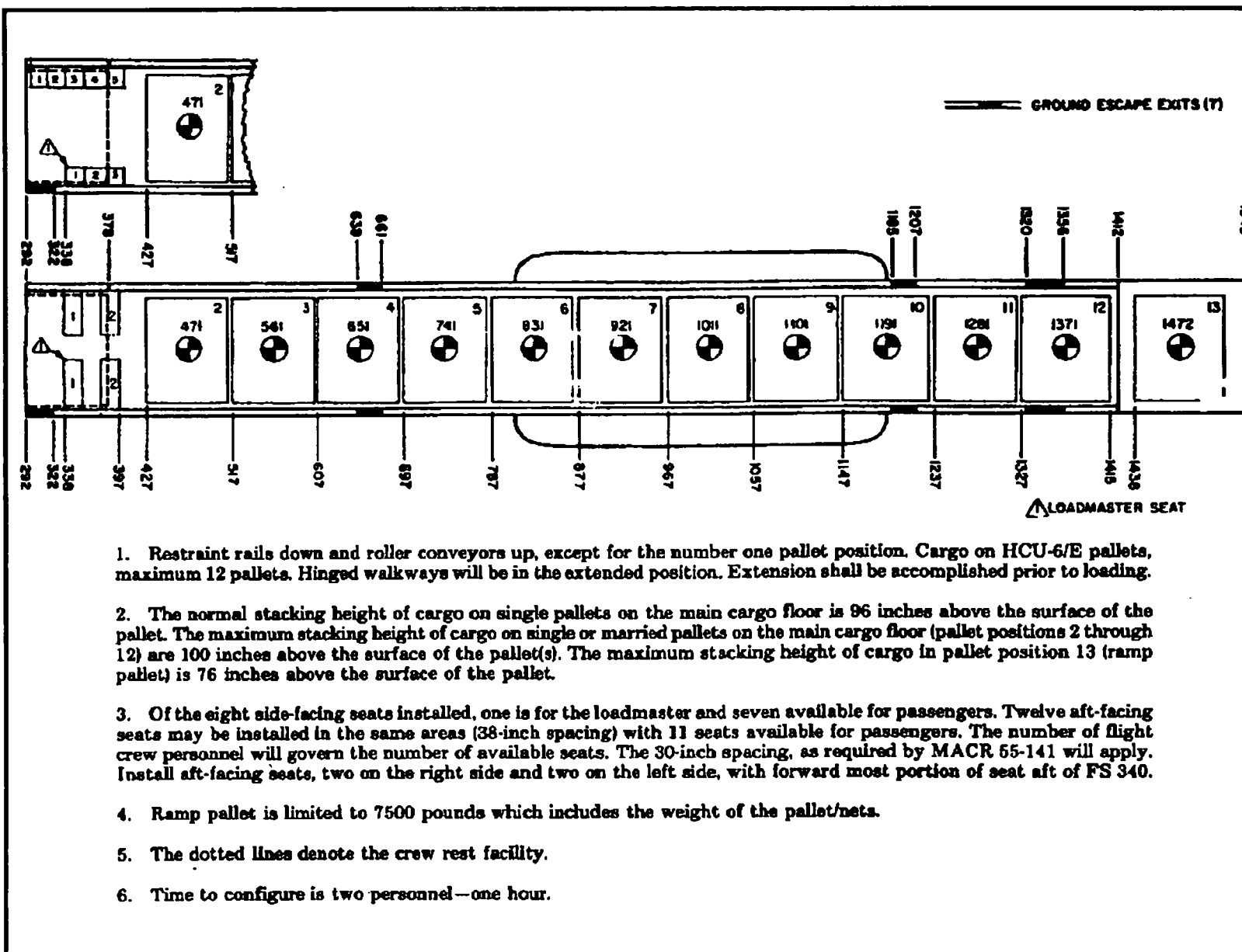


Figure A-11. C-130 Configuration P-1.



1. Restraint rails and intermediate roller conveyors installed to provide maximum pallet utilization.
2. If cargo permits, sidewall seats may be available.
3. Time to configure is one person, one-half hour.

Figure A-12. C-141 Configuration C-1.



C-141 CONFIGURATIONS

Figure A-15. C-141 Configuration CP-1.

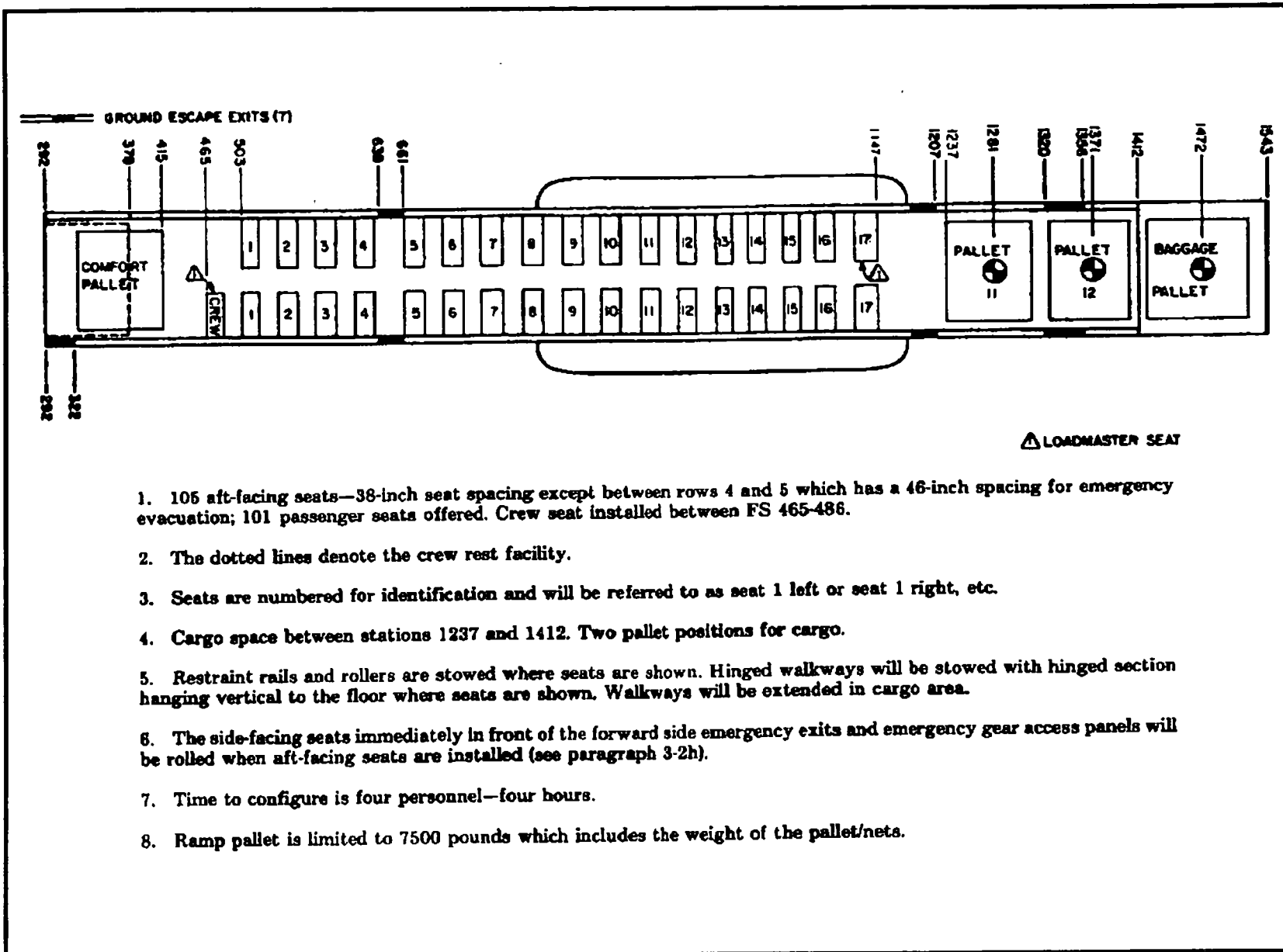
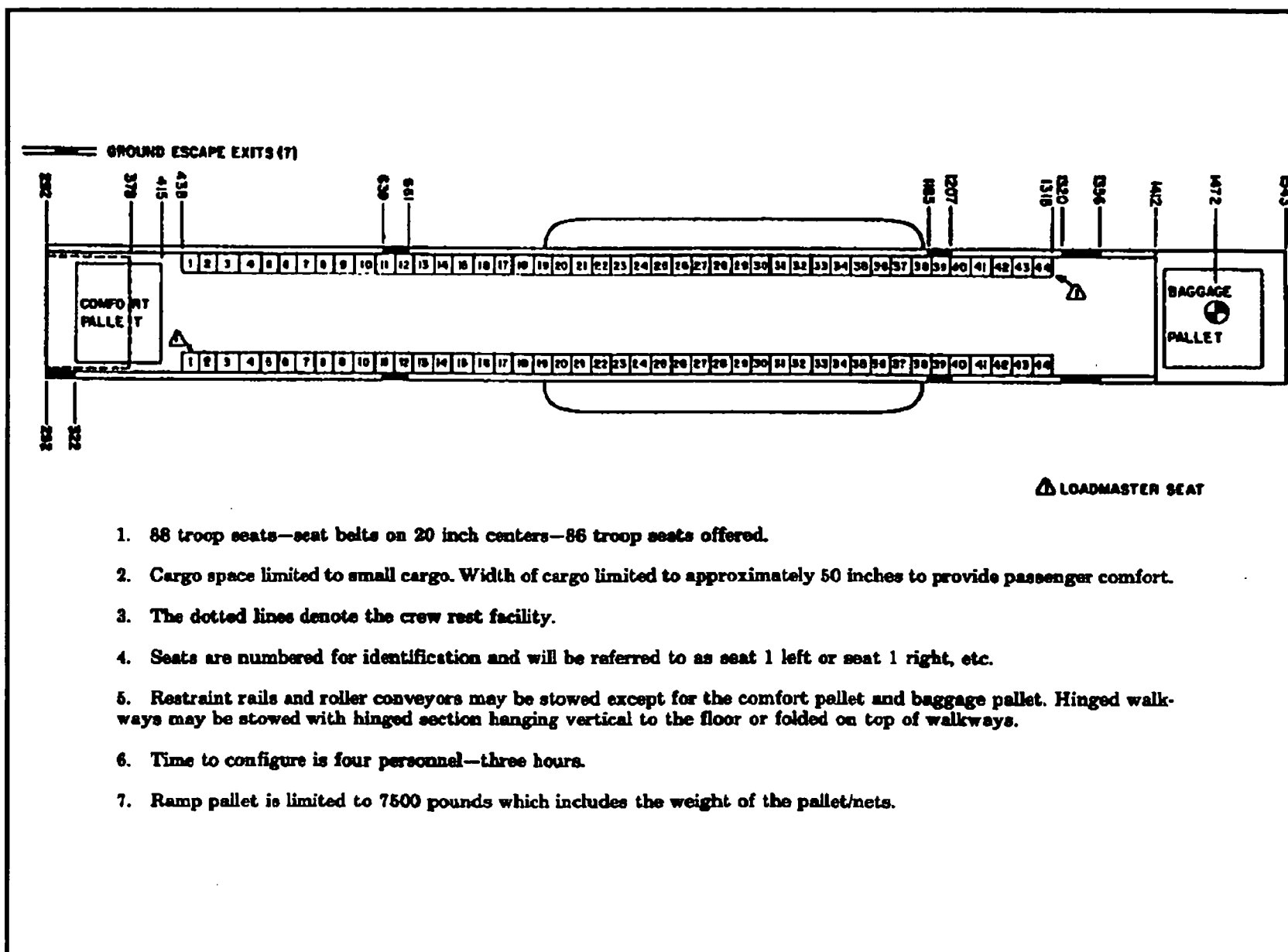
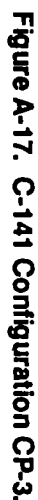


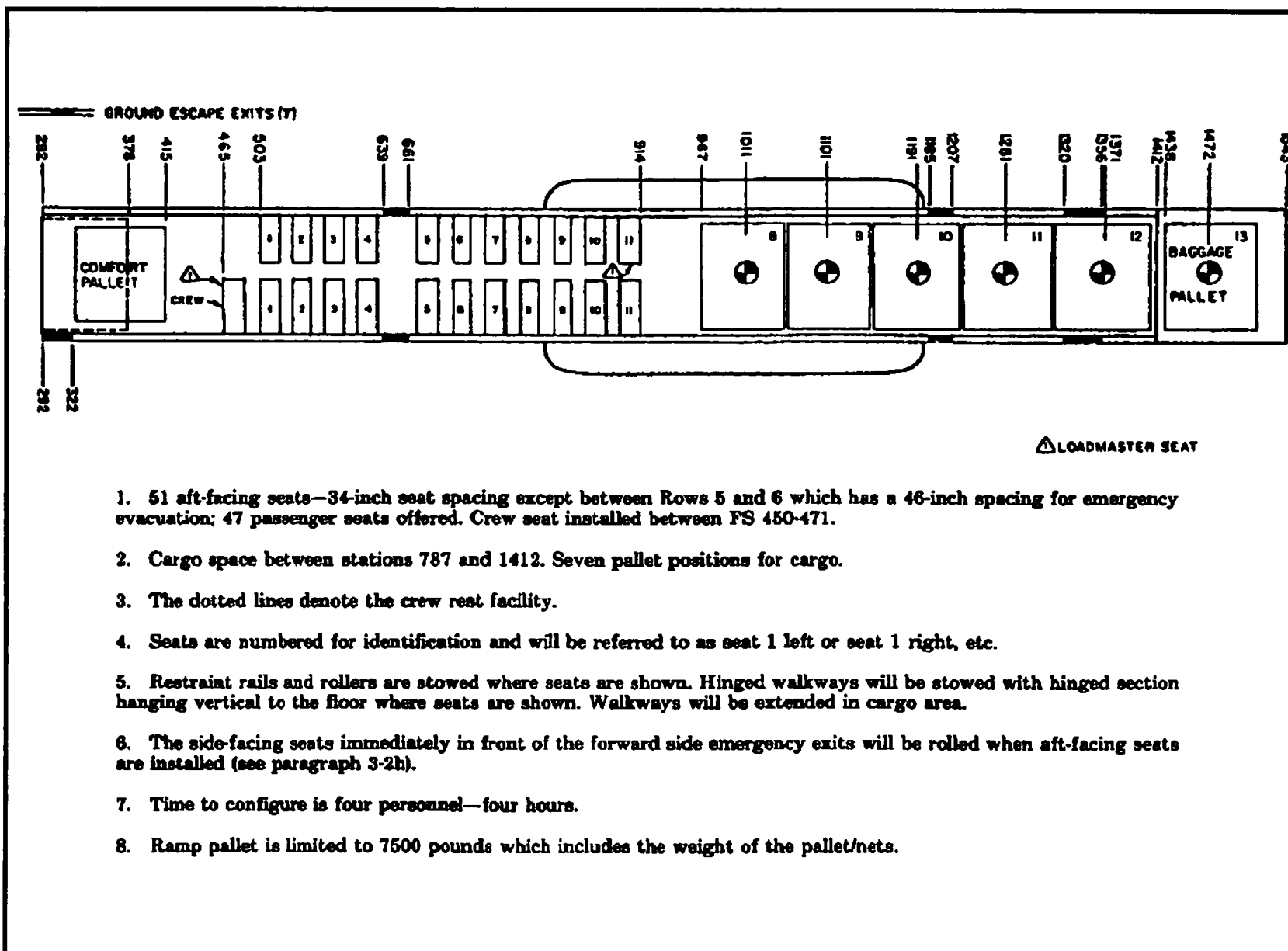
Figure A-16. C-141 Configuration CP-2.





- NOTE:** Latrine facilities limit flight duration to approximately three hours.

Figure A-18. C-141 Configuration P-5.



Block 14 - Fluid Leaks

Make sure there are no fuel, oil, hydraulic, brake, or cooling system leaks.

A leak is a loss of fluid or fuel at a rate that is readily detected or seen. Five drops or more per minute from a cooling system, crank case, or gear case is considered a leak. Fuel or brake system leaks, no matter how minor, will result in the item being frustrated. A damp or discolored seal need not be considered a leak unless the above conditions exist.

Block 15 - Mechanical Condition

- a. Engine runs.
- b. Brakes are operational:
 - Foot brake.
 - Emergency brake.

Block 16 - Battery

Properly secure the battery with hold-down bracket to include cable routing and insulation. The battery must not be allowed to short out with the metal casing/compartment. All battery cell caps must be in place and secure.

If the battery is disconnected, tape the post/cables to prevent sparks from contacting metal.

Check batteries for cracks or leakage of battery acid.

Block 17 - Fuel Tank(s)

- a. One-Half (1/2) Tank. Self-propelled vehicles may be transported with a maximum of three-quarters of a tank of fuel when placed on the cargo floor of the aircraft (with a copy of HQ AFLC message 112045Z Jun 90). Without the message, vehicles are limited to one-half tank regardless of location. Vehicles placed on the ramp will not exceed one-half tank of fuel, with the filler opening positioned on the up high side of the ramp.
- b. One-Fourth (1/4) Tank. One-fourth tank applies to trailer-mounted equipment

disconnected from its prime mover and all equipment planned for AMC channel missions.

- c. Drained (As required). Equipment that is mounted on a single axle (trailer) that is disconnected from its prime mover (truck) and loaded with its tongue resting on the aircraft floor must be drained but need not be purged.
- d. Fuel Tank Caps Installed. There are two types of fuel tanks: pressurized and nonpressurized. The type will be stenciled onto the gas cap. When transporting the different types of fuel tanks, take the following steps:
 - On pressurized tanks, ensure the caps are in the locked position.
 - On nonpressurized tanks, ensure the caps are in a semilocked position, with about one-quarter turn to open. This will allow pressure to escape from the tank while in flight.

Block 18 - Jerry Cans (Secure, Fuel Level, Seals)

Secure jerry cans, DOT 5L, in racks designed to hold them and prevent movement. In this case, no hazardous cargo certification will be required when moving under a Chapter 3 move of TM 38-250.

Prevent metal-to-metal contact between jerry cans not secured in racks by using cushioning material or fiberboard (MRE box sleeves). No DD Form 1387-2 will be required under a Chapter 3 move of TM 38-250.

Palletized jerry cans with fuel are not acceptable for military air shipments.

Jerry cans are authorized for transporting flammable liquid fuel stock in quantities when combined with the fuel shipped in the tanks of the vehicles or equipment does not exceed a two-full-tank supply. For example, a vehicle on the ramp of a C-130 has a 10-gallon fuel tank. You are limited to 5 gallons because of the ramp restrictions. You would be allowed to carry three jerry cans of fuel.

Maximum amount of fuel is 5 gallons or 1 inch below filler neck.

All jerry cans must have serviceable seals before use for air shipment. To check seals, fill jerry cans and turn upside down. If fuel leaks, replace the seals. If the seals leak, the jerry cans will be frustrated. Jerry cans are authorized for shipment only between CONUS stations.

Block 19 - Dimensions (Fits A/C Profile or Contour)

The dimensions must be within aircraft loading envelope capabilities. Measure the length, width, and height of items to ensure that they do not exceed aircraft limits.

Mirrors that extend beyond the body of the vehicle must be folded in.

Some vehicles will require that the canvas and bows be removed before loading.

Antennas, exhaust stacks, and other reducible objects may require removal before loading.

Block 20 - Center of Balance (Both Sides)

CB must be accurately computed and marked on both sides as shown in Appendix G of FM 55-12.

The suggested marking method is with tape and grease pencil. Place tape that is at least 1 by 3 inches vertically at the CB of the item. Indicate the center of balance and the distance from the front axle in inches. Place masking tape that is at least 1 by 3 inches horizontally at the CB of the item. Place this tape directly above the vertical tape to form a T and indicate the gross weight of the item.

Apply these markings only after the secondary load is applied and the vehicle is weighed on scales. You should keep a journal of axle weights, distances, and CB data in case tape or grease pencil markings become illegible or fall off during the move.

Block 21 - Scale Weight (Both Sides)

The scale weight must be accurately determined and marked on both sides of the item, as indicated above.

Block 22 - Axle Weights (Both Sides)

The shipping unit will determine the weights of the axles by actually weighing the vehicle.

Wheel and axle weight must be within allowable limits for the cargo floor.

Gross axle weight(s) must be marked on both sides of the vehicle above the axles.

Block 23 - Tiedown Points (Serviceable)

Ensure the serviceability of each tiedown point, such as clevis or lifting ring. Ensure no cracks are visible and safety pins or locking nuts are installed, if applicable.

Block 24 - Pintle Hooks/Clevises

- a. Serviceable. If the vehicle or equipment has a pintle hook or clevis installed, check them for serviceability and make sure no cracks are present.
- b. Safety Pin Attached. Install safety pins for pintle hooks if planning to push or tow a trailer on or off the aircraft.

Block 25 - Vehicle Equipment Secure (Tools, tires, antennas, etc.)

Secure axe, pick, and shovel.

Secure spare tire and tools.

Secure radios and fire extinguisher.

Block 26 - Lox/Nitrogen Cart (Vent Kit)

Ensure the vent kit has all necessary hoses, clamps, and tools to connect the item to the aircraft vents, as required.

Ensure hoses are clean of all oil, grease, dirt, and so forth.

Block 27 - Tire Pressure

Underinflated tires may cause the rim to bottom out during turbulence and cause damage to the aircraft floor.

APPENDIX D

463L CARGO SYSTEM

INTRODUCTION

The 463L cargo system encompasses all phases of cargo loading including materials-handling equipment, cargo-loading platforms, restraint equipment, and in-aircraft systems. The 463L system is the Air Force standard for moving concentrated cargo.

DUAL-RAIL SYSTEM

The dual-rail system is installed in all airlift or 463L-capable military aircraft. This system consists of rows of rollers that allow the palletized cargo to easily move into the aircraft. Many of these rollers are stowable to convert the cargo deck to a flat, clear loading surface for wheeled cargo. The side rails guide the pallets into the aircraft and provide lateral and vertical restraint. These rails are equipped with detent locks that hold the pallet securely in place once inside the aircraft. These locks also prevent the forward and aft movement of pallets during flight.

463L PALLET CONSTRUCTION

The 463L pallet (Figure D-1) is made of corrosion-resistant aluminum with a soft wood

or fiberglass core and is framed on all sides by aluminum rails. The rails have 22 tie-down rings attached with 6 rings on each long side and 5 rings on each short side. Each ring has a 7,500-pound restraint capacity. The rails also have indents (notches) that accept the detent locks located on numerous types of materials-handling equipment and on all airlift-capable aircraft. The overall dimensions of the 463L pallet are 88 inches long by 108 inches wide by 2 1/4 inches thick. However, the usable dimensions of the upper surface are 84 inches wide by 104 inches long. This allows 2 inches around the periphery of the pallet to attach straps, nets, or other restraint devices. An empty 463L pallet weighs 290 pounds (355 pounds with a complete set of nets) and has a maximum load capacity of 10,000 pounds. The maximum pounds per square inch for the 463L pallet is 250 pounds. Concentrated loading should not exceed 330 pounds on any one square foot of surface. If a load exceeds either of these limitations, then shoring must be used to spread the load over a larger area.

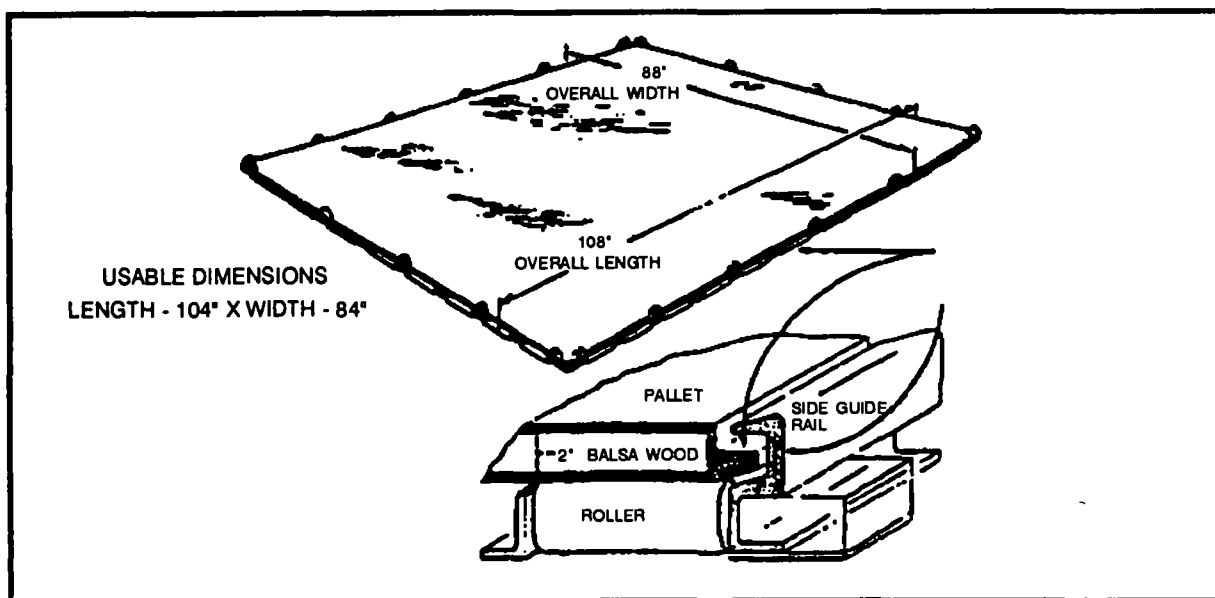


Figure D-1. 463L Master Pallet Construction.

463L PALLET NETS

There are three nets to a set (Figure D-2): one top net (yellow) and two side nets (green/black). The side nets attach to the rings of the 463L pallet and the top net attaches by hooks to the rings on the side nets. These nets have multiple adjustment points and may be tightened to conform snugly to most loads. A complete set of 463L nets provides adequate restraint for a maximum of 10,000 pounds of cargo when properly attached to a 463L pallet. For 463L pallets that do not exceed 45 inches in height or 2,500 pounds, a single top net will be used to secure the load. When a top net is used, the belly band (Figure D-2) must not be more than 8 inches from the top of the pallet surface. As stated previously, the 463L pallet has a maximum height of 96 inches restraining 10,000 pounds. If the pallet exceeds 96 inches but is less than 100 inches, a maximum weight of 8,000 pounds is allowed. A complete set of nets weighs 65 pounds.

It is important to inspect the pallets and nets for serviceability before use. Failure to use serviceable systems will result in inspection failure during the joint inspection. Refer to the checklist at the end of this appendix for inspection guidance. Return questionable components to the Air Force/ITO for proper disposal.

463L PALLET BUILDUP

Palletize cargo from the heaviest to the lightest (Figure D-3). Distribute large and heavy objects from the center of the pallet outwards to prevent the pallet from becoming heavy on one end. Doing this also helps maintain the center of balance at or near the center. Place lighter or smaller items on top of or beside the heavier cargo. Cargo with special handling labels must face outward whenever possible. Load hazardous cargo so that it is accessible to the aircrew and in such a manner to allow for ease of jettison. Construct the load in a square or pyramid shape whenever possible to make the load stable, easy to handle, and easier to secure on the pallet. Always put adequate dunnage under 463L pallets before cargo placement. The dunnage consists of a minimum of three 4- by 4- by 88-inch pieces of lumber equally spaced

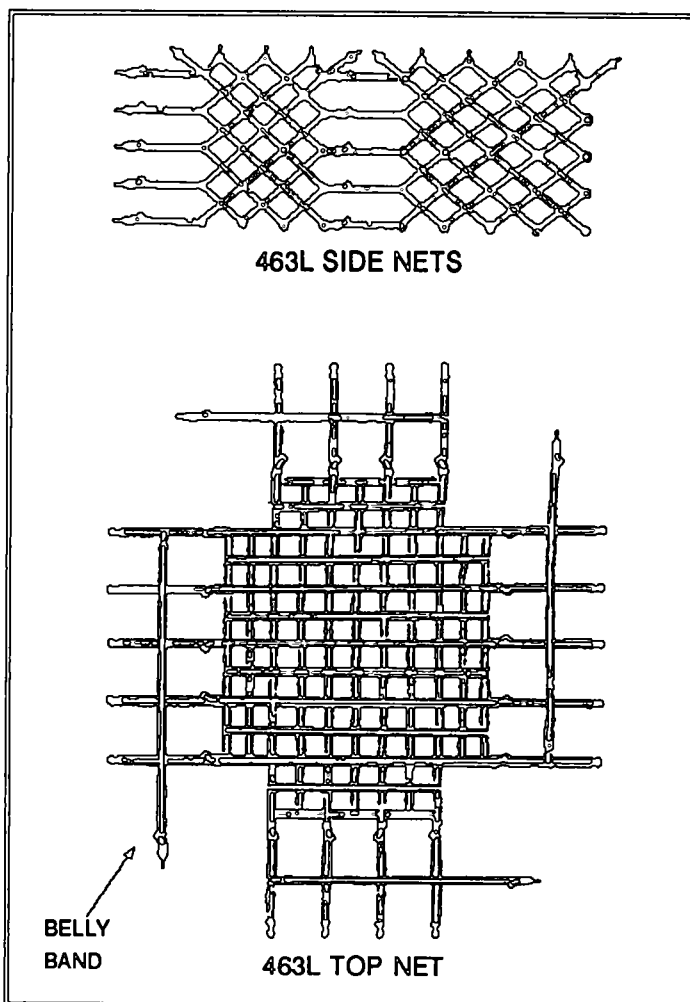


Figure D-2. 463L Pallet Nets.

under the 463L pallet. This aids the movement of the pallets by forklift and protects the lower surface from damage. Remember to ship the dunnage with the pallets for storage after unloading at the destination. Pallets that contain water-sensitive cargo, such as electronics and paperwork, or water-absorbent cargo, such as baggage, should use the plastic 463L pallet cover, NSN 3990-00-930-1480.

Unit SOPs for pallet markings may differ; however, the minimum requirement is AF Form 2279 (Figure D-4). Pallet ID cards may be obtained from your servicing TALCE. Units should produce their own marking standards for SOPs.

Each aircraft has restrictions on the dimensional size and shape particular to that aircraft. Check the specific requirements of the aircraft for which the load is prepared.

Place the two side nets around the cargo on the pallet, and hook the hooks into the pallet rings. Start at one corner and work around the pallet (Figure D-6). Make sure the straps and hooks of the net cross at the corners of the pallet. Pull the net as high as it will go and hook the two side nets together. Each side net has adjustable straps between the long and short sides to make adjustments depending on the cargo placement. Side nets correctly hooked to the pallet rings will have O rings and tension-adjustable hooks to join together, uniting the two side nets. Do not tighten these straps until the side nets are hooked to the top net.

Top Net

Center the top net over the cargo. The long side of the top net goes with the long side of the

side nets and pallet. Hook the top net into the side nets using the O rings located on the top portion of the side nets. If the cargo height restricts the use of these O rings, use the large O rings found about halfway up the side nets. Never use the bottom row of O rings with the hooks to secure the top net in place over the cargo. Cargo permitting, use the same row of rings on the side nets to ensure that the top net pulls evenly. When the top net is hooked in, two people should pull evenly on all the straps opposite of each other to tighten the top net, ensuring that the net stays equally distributed over the cargo. When all the straps are tightened, including the side net straps, tuck the loose ends of the straps into the netting to prevent snagging during loading or unloading operations.

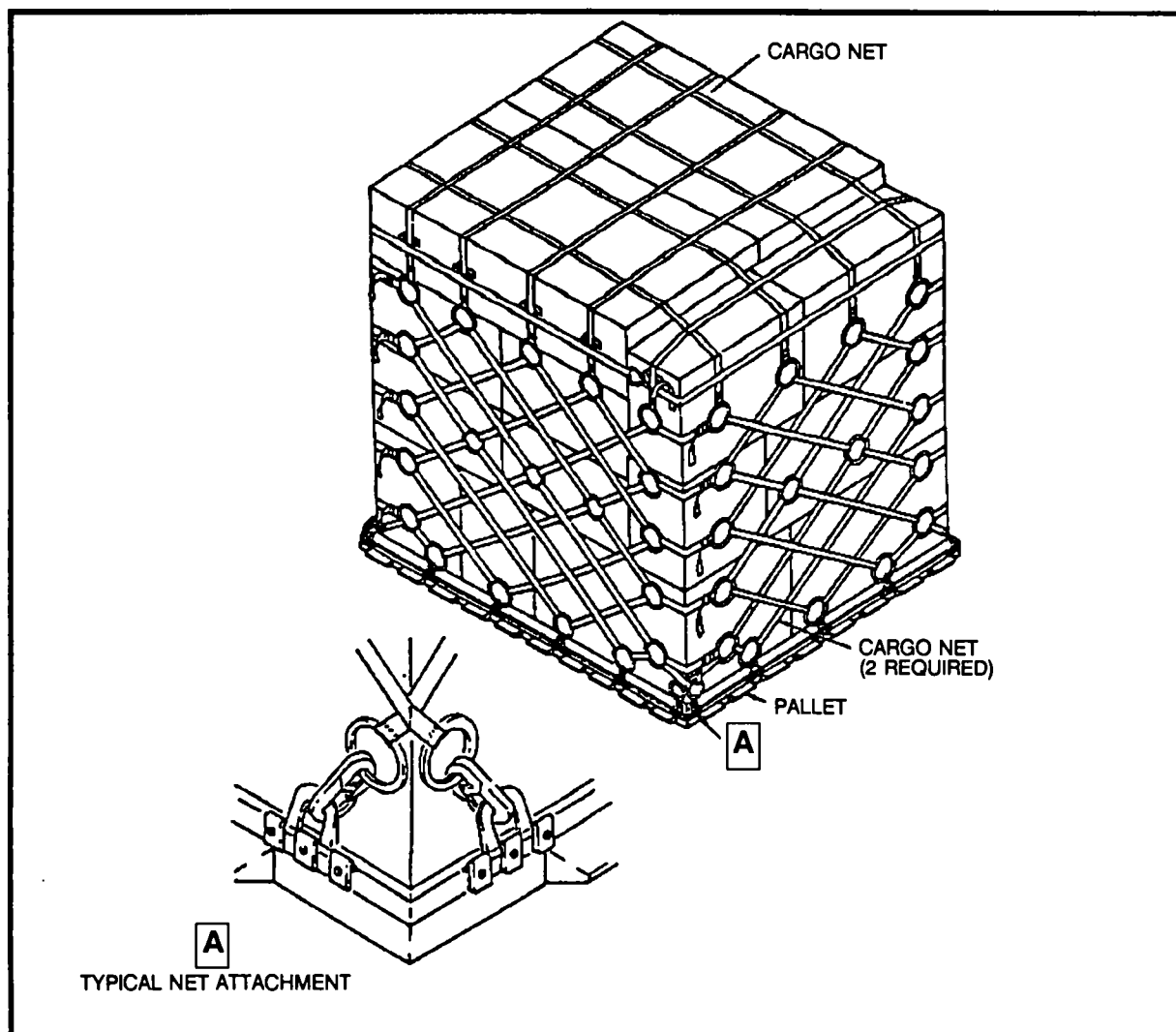


Figure D-6. Typical Net Attachment.

PALLET WEIGHT

Weigh each 463L pallet built with cargo, and record the scaled weight on all copies of the cargo manifest. Ensure the scaled weight is clearly marked on two sides (one on either 88-inch side and one on either 108-inch side) of the 463L pallet. Pallet weight markings (Figure D-7) may be stapled to the net. Measure the cargo height and record it on the cargo manifest.

NOTE: Include the weight of three-point dunnage with the pallet, as the dunnage will accompany the pallet on the aircraft.

Units should use AF Form 2279 (Figure D-4) or create their own version. It is important that the data be clearly posted and correct. As a rule, the pallet identification cards must contain the following information:

- Pallet identification number; for example, PC-2.
- Aircraft configuration; for example, C-141/C-2M.
- Originating station; for example, Langley Air Force Base, VA.
- Net weight of pallet.
- Miscellaneous information; for example, hazardous material.
- Destination station; for example, Pope Air Force Base, NC.
- Gross weight of pallet.

These pallets can be moved with a forklift, but the tines must be a minimum of 72 inches long. Use only forklifts rated at a lifting capacity equal to or greater than pallet weight. See Appendix F for guidance on MHE used in air movements.

MARRIED PALLET

Cargo of odd shapes and sizes may require movement by air. When the requirement to ship cargo exceeds the dimensions of a single 463L pallet, join two or more 463L pallets together (Figure D-8), forming a marriage of the pallets. This is often referred to as a pallet train. It is

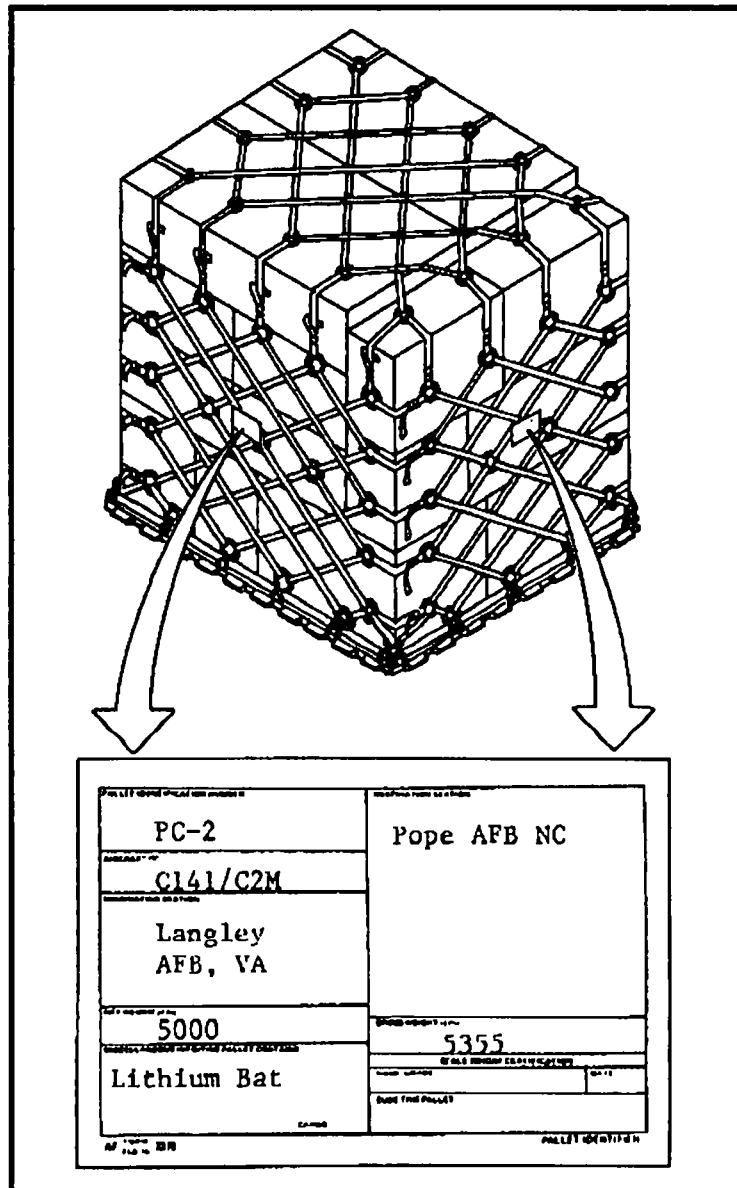


Figure D-7. 463L Pallet Weight Markings.

always to work pallet trains from an elevated platform. Place the pallets on a rollerized cargo deck, a rollerized flatbed truck, or as a last resort, a K loader (this should be avoided if possible because it will tie-up the K loader until the pallets are loaded onboard the aircraft). Align the indents of the pallet along the 108-inch side of the pallet. Space pallet couplers (Figure D-6) in the indents to lock the pallets together. Contact your affiliated ALCS for couplers.

To place cargo on married pallets, load long, heavy cargo first, distributing weight evenly over the pallet to avoid a heavy-ended

TIE-DOWN EQUIPMENT

Table D-1 gives prices and national stock numbers (NSNs) for components of the 463L

pallet system. Units should purchase the items or draw through the local supply system adequate numberstoconductloadteamtrainingonaregular basis.

Table D-1. 463L Typical Tie-Down Equipment.

NOMENCLATURE	NSN	SIZE	COST*
Pallet, CGO Aircraft HCU-6E	1670-00-820-4896	88 x 108 x 2 1/2"	904.85
Net, CGO, Tie-Down Pallet, Top, HCU15C	1670-00-969-4103	88 x 108"	111.32
Net, CGO, Tie-Down Pallet, Side, HCU-7/E	1670-00-996-2780	88 x 108"	116.66
CGU-1/B, Nylon Strap 5,000-lb Capacity	1670-00-725-1437		12.04
MB-1, Tie-Down Chain 10,000-lb Capacity	4010-00-516-8405		9.06
MB-1, Tensioning Device 10,000-lb Capacity	1670-00-212-1149		17.59
MB-2, Tensioning Device 25,000-lb Capacity	1670-00-545-9063		400.00
Cover, Plastic Pallet 4636, HCU-6/E	3990-00-930-1480	Large, 10 per Roll	53.41
Pallet, Coupler	1670-01-856-0875	Lockheed C-130, C-141, and C-5	30.79
Pallet, Coupler	1670-01-302-3637	McDonnell-Douglas KC-10	114.00
Wheel, Load, Weigher Scale, Load, Wheel Model MD 400 Manufacturer's Code 06433 Kippenbrock Scale Service 9539 1st View Street PO Box 8125 Norfolk, VA 23503 PH: (804) 588-0061, Approx: 900.00	6670-00-856-0875		870.14

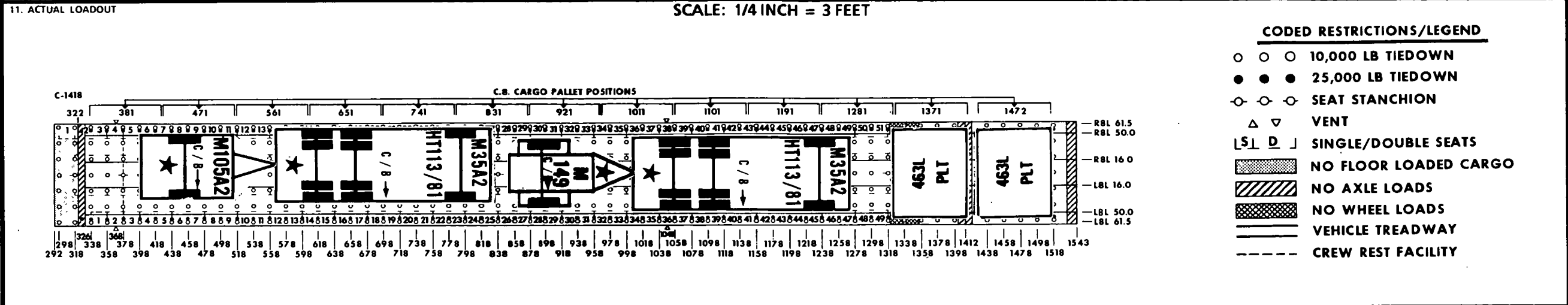
*Costs are from FY 92 supply listing.

CHECKLIST FOR PALLET BUILDUP

The following checklist will help the unit prepare for deployment:

- _____ 1. Are you prepared to follow good safety practices?
- _____ 2. Do personnel have steel-toed safety shoes and work gloves, if necessary?
- _____ 3. Have personnel been briefed on proper lifting techniques?
- _____ 4. Is the pallet skin free of damage, top and bottom? Are there any bent lips on the 88-inch side?
- _____ 5. Are tie-down rings serviceable?
- _____ 6. Is the pallet level and not warped?
- _____ 7. Is the pallet free of corrosion?
- _____ 8. Is the pallet clean and free of dirt?
- _____ 9. Is the pallet right side up?
- _____ 10. Is the pallet placed on three-point dunnage?
- _____ 11. Is the cargo to be placed on the pallet securely packaged?
- _____ 12. Does the cargo have required markings?
- _____ 13. Are hazardous cargo labels (SFs 400 to 422) attached to items of hazardous cargo or their containers? Is a DD Form 1387-2 (Special Handling Data/Certification) attached to all hazardous sensitive items and nonhazardous sensitive items that leave owning unit custody?
- _____ 14. Is cargo that is marked with arrows (THIS SIDE UP) positioned with arrows up?
- _____ 15. Are hazardous items on the pallet compatible with TM 38-250?
- _____ 16. Is all hazardous cargo positioned for easy access in flight? Are hazardous cargo labels visible from an 88-inch side of the pallet?
- _____ 17. Is the cargo arranged on the pallet to meet the following criteria:
 - Are the heavier boxes and crates placed on the bottom of the pallet load?
 - Is lighter, more fragile cargo placed on top of the pallet load?
 - Is the cargo arranged and properly stacked so that it is stable?
- _____ 18. Is the height of the buildup pallet 96 inches or less from the top skin of the pallet?
- _____ 19. Is the pallet loaded with more than 10,000 pounds of cargo?
- _____ 20. Is the cargo loaded so that it is no more than 104 inches wide with no overhang over either of the 108-inch sides?
- _____ 21. Is the pallet loading limited to less than 250 pounds per square inch on the pallet's surface?
- _____ 22. Is the cargo susceptible to weather damage? (If so, cover it.)
- _____ 23. Is the cargo secured to the pallet using two side nets and a top net?
- _____ 24. Is the pallet smaller than 48 inches and 2,500 pounds? (If so, use a single top net.)
- _____ 25. Does the pallet have 22 serviceable rings?

1. UNIT BEING AIRLIFTED (Name or Number) 101st ABN	2. UNIT IDENTIFICATION CODE WABHAA	3. TYPE MOVEMENT PLAN PROVIDE COMFORT/STRATEGIC	4. MOVEMENT DATE 17 DECEMBER 1992	5. UNIT AIRCRAFT LOAD NO. 1 OF 21	PAGE 1 OF 1 PAGES
6. MISSION NUMBER	7. AIRCRAFT SERIAL NUMBER (Last Five)	8. CONFIGURATION C-2M	9. DEPARTURE AIRFIELD/ETD KADENA AB, JAPAN/1200Z	10. DESTINATION AIRFIELD/ETA CLASSIFIED/CLASSIFIED	



LOAD SEQUENCE a.	ITEM MODEL AND NOMENCLATURE/DESCRIPTION b.	VEHICLE PACKAGE NO. OR SERIAL INCREMENT NO. c.	d. REMARKS (Special Handling, Shoring)		e. PLANNED LOAD DATA						f. ACTUAL LOAD DATA				g. REMARKS COOES (For use in Column d(1))
			REMARKS CODE (From col g) (1)	OTHER (2)	TOTAL (In Inches)			GROSS WEIGHT (Total Pounds)	FUSELAGE STATION	MOMENT (10,000)	HEIGHT (Total Inches)	GROSS WEIGHT (Total Pounds)	FUSELAGE STATION	MOMENT (10,000)	
					LENGTH	WIDTH	HEIGHT								
1	1½ TON, TRAILER, CARGO M105A2	T-1	1A		166	83	82	4,400	470	2,068					1. Off center: 1A. RIGHT 1B. LEFT 2. Center line load. 3. Shoring Required: 3A. PARKING 3B. ROLLING 3C. SLEEPER 3D. SPECIAL 4. Must be positioned in direction of arrow. 5. Sequence by actual weights. 6. Hazardous Cargo: 6A. DD Form 1387-2 6B. DD Form 2133 7. Maximum fuel: 7A. 1/2 TANK 7B. 1/4 TANK 8. Equipment drained/purged: 8A. ORAINED NOT PURGED 8B. PURGED 9. Vent kit required. Other Conditions: Identify in column d(2)
2	2½ TON, TRUCK, CARGO M35A2	M-1	1A,6B 7C		265	96	89	16,700	700	11,690					
3	TRAILER, WATER M149A1	T-4	2,8A		162	82	77	2,500	900	2,250					
4	2½ TON, TRUCK, CARGO M35A2	M-4	2,6B 7C		265	96	89	14,200	1140	16,188					
5	463L PALLET	PC-1	2		88	108	76	5,860	1371	8,034					
6	463L PALLET	PC-2	2		88	108	76	2,340	1472	3,444					
7	TROOPS (4)							840	398	334					
12a. PASSENGER SEATS PLANNING DATA			13. TOTAL WEIGHT / MOMENT FROM REVERSE												
NUMBER SEATS	AVG WEIGHT (Pounds Each)	TOTAL PLANNED WT.	14. TOTAL												
4	210	840													
12b. PASSENGER SEATS ACTUAL DATA			15a. PLANNED LOAD DATA CERTIFICATION		DATE CERTIFIED 14 DECEMBER 1992		TYPED/PRINTED NAME, GRADE, ORGANIZATION OF PLANNING OFFICIAL THOMAS P. FLEMING, SFC, JSJTC				SIGNATURE OF PLANNING OFFICIAL <i>Thomas P. Fleming</i>				
NUMBER SEATS USED		TOTAL WEIGHT (Pounds)	15b. ACTUAL LOAD DATA CERTIFICATION		DATE CERTIFIED 14 DECEMBER 1992		TYPED/PRINTED NAME, GRADE, ORGANIZATION OF LOAD DATA VALIDATOR LIBBY V.D. QUINLAN, JR., MSgt, 1492 ATTF/OL A				SIGNATURE OF LOAD DATA VALIDATOR <i>Libby V.D. Quinlan</i>				

DD Form 2130-3, DEC 88

Previous editions are obsolete.

C-141B CARGO MANIFEST

Figure E-1. DD Form 2130-3.

UNIT AIRCRAFT UTILIZATION PLAN								1. UNIT/TYPE PLAN (1) PROVIDE COMFORT				2. UIC (1) WABHAA		3. UTC (1)		4. DATE PREPARED (1) 13 DECEMBER 1992				PAGE 1 OF 2 PAGES									
5. UNIT PROJECT OFFICER (Name, grade and organization) (1) KIMBERLY R. LAMBERT, SGT, 101st ABN, FT CAMPBELL, KY 42223								6. TELEPHONE NO. (1) (502) 798-2911				7. MAC PLANNER/CERTIFYING OFFICIAL (Name, grade and organization)																	
SECTION I: LOAD ID DATA (See Note 1 - Complete columns a through h, items 8 through 21)								SECTION II. PRELIMINARY LOAD PLAN (PART A: Type Aircraft; PART B: Total Aircraft; COLUMNS i through aa, ITEMS 8 through 23: Load Plan) (See Note 3)																					
ITEM NUMBER	QNTY TOTAL	ITEM DESCRIPTION	SEE NOTE 2	INCHES			POUNDS		PART A C-141B (ACL 68,725) C-5B (ACL 205,000) DC-8 (ACL 56,000)																QNTY TOTAL	ITEM NUMBER			
				LENGTH	WIDTH	HEIGHT	EMPTY WEIGHT	PLANNED WEIGHT	PART B 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			17	18	19
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa		
08	2	5/4 TON T59482-02 M1008, TRK, CARGO	0	221	81	77	5900	8400	1																		2	8	
9	5	2 1/2 TON X40009-02 M35A2, TRK, CARGO	0	265	96	102	13180	15500	1		1																5	9	
10	2	1 1/2 TON W95811-01 M105A2, TRLR, CARGO	0	166	83	98	2670	3670	1																		2	10	
11	2	5 TON X63299-08 M816, TRK, WRKR WVN	0	355	99	105	34820	34820	1																		2	11	
12	3	5 TON X49051-04 RTFL-10, FORKLIFT	0	277	107	98	33500	33500			1																3	12	
13	3	2 LITTER T38707-01 M996, TRK, AMBULANCE	0	206	85	100	7565	7600			1																3	13	
14	3	W98825-02 M149A2, TRLR, WATER	0	162	82	77	2540	4000			1																3	14	
15	14	5 TON X40794-08 M923, TRK, CARGO	0	314	98	87	22020	24500					1		1			1/									14	15	
16	7	5 TON X40931-08 M925, TRK, CGO WVN	0	327	98	87	22458	25000					1						1/								7	16	
17	2	2 1/2 TON X61494-01 M109A3, VAN, SHOP	X	279	100	130	16170	16200											1/1								2	17	
18	7	1 1/2 TON T61494-01 M998, TRK, UTILITY	0	187	96	74	5280	5500							1												7	18	
19	8	CUBE (Each) 463L PALLETS 418	✓	88	108	76	355	2600	1				1														8	19	
20	6	CUBE (Each) 440	✓	88	108	80	355	3775					1														6	20	
21	362	TROOPS 210		SEATS AVAILABLE					10		16		6		6			38		38			140				362	21	
22	TOTAL TYPE LOADS								2		3		6		7			1		1			1						22
1. Completed by project officer.		3. Mobile Load (Stacking)/ Side - by - Side Planning (To be shown in aircraft load column - see example)						23. TOTAL PLANNED WEIGHT		(2,6)		(1,5 & 10)		(15-20)		(4,7-9,11, 12,14)		(3)		(13)			(21)						
2. Use these marks to indicate: X = Outsized ✓ = Bulk Cargo O = Oversized		A. Equip/items planned side - by - side (Use slash mark) B. Like item to be stacked (Circle Number) C. Other items to be stacked (P= Primary; S= Items to be stacked on primary)								68,190		65,600		67,875		67,300		156,755		179,955			42,000						
										i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z		

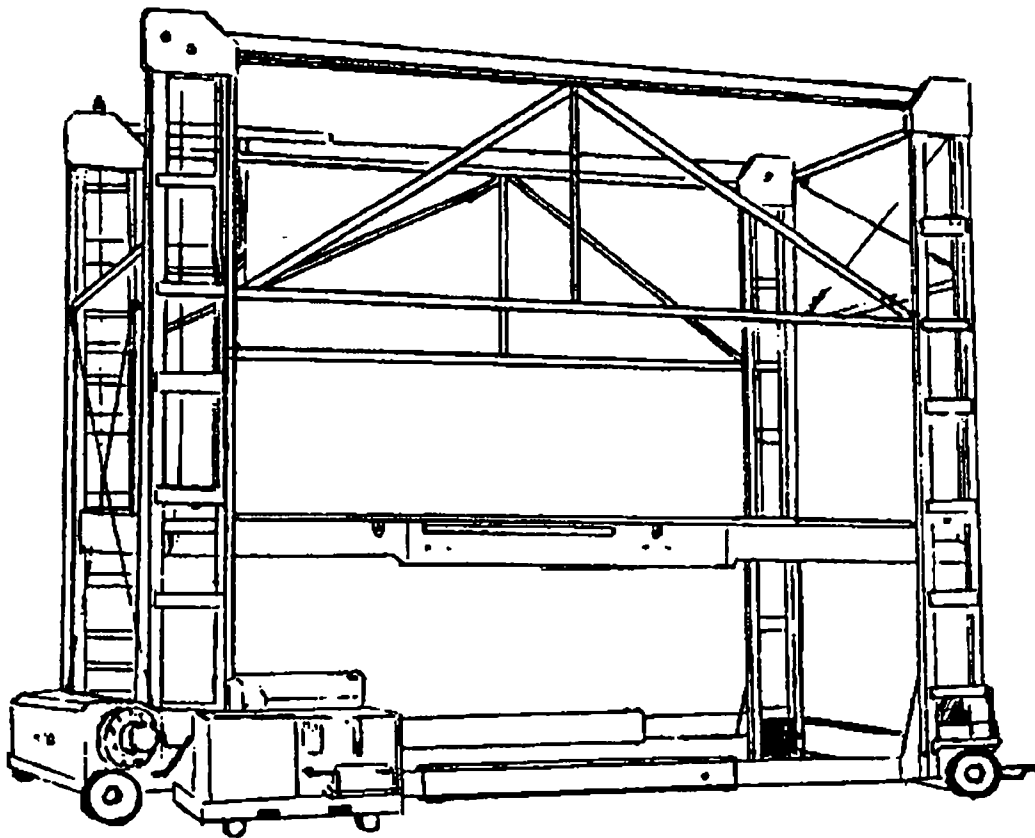
DD Form 2327, FEB 84

Figure E-2. DD Form 2327.

CL-3 Wilson Loader

The CL-3 Wilson loader (Figure F-15) is the newest of the wide-body loaders. It was purchased to support the acquisition of the KC-10 and additional Civil Reserve Air Fleet aircraft.

NOTE: Because of the aircraft fuselage curvature, the CL-3 Wilson loader cannot be used to load wide-body lower lobes. Rollers can be turned over to permit loading of wheeled loads without the plywood subfloor.



SPECIFICATIONS

Ground Movement Speed	
Low	1 mph
High	2.5 mph
Towed	5 mph
Length	318 Inches
Width	243 Inches
Height	279 Inches
Elevator Platform	
Dimensions	125 x 285 inches
Minimum Height	19 inches
Maximum Height	217 Inches
Maximum Load	30,000 pounds

Figure F-15. CL-3 Wilson Loader.

PUSHER VEHICLE

The pusher vehicle is a vehicle with a rated towing capacity modified by the addition of a front pintle hook (Figure F-16). These vehicles dramatically aid in loading trailers on military cargo aircraft. Pusher vehicles allow the drivers a direct view of the trailer as it moves aboard the aircraft. This is quicker and safer than having the driver rely

on rearview mirrors or hand signals. Probably the best vehicles to use as pusher vehicles are the RT 4000-series forklifts as they swivel in the middle, allowing the driver to adjust the position of the trailer without moving the pusher vehicle. Any time quantities of trailers will be moved on aircraft, you should arrange for pusher vehicles. TB 9-2300-415-40 gives specific guidance for front pintle hook construction.

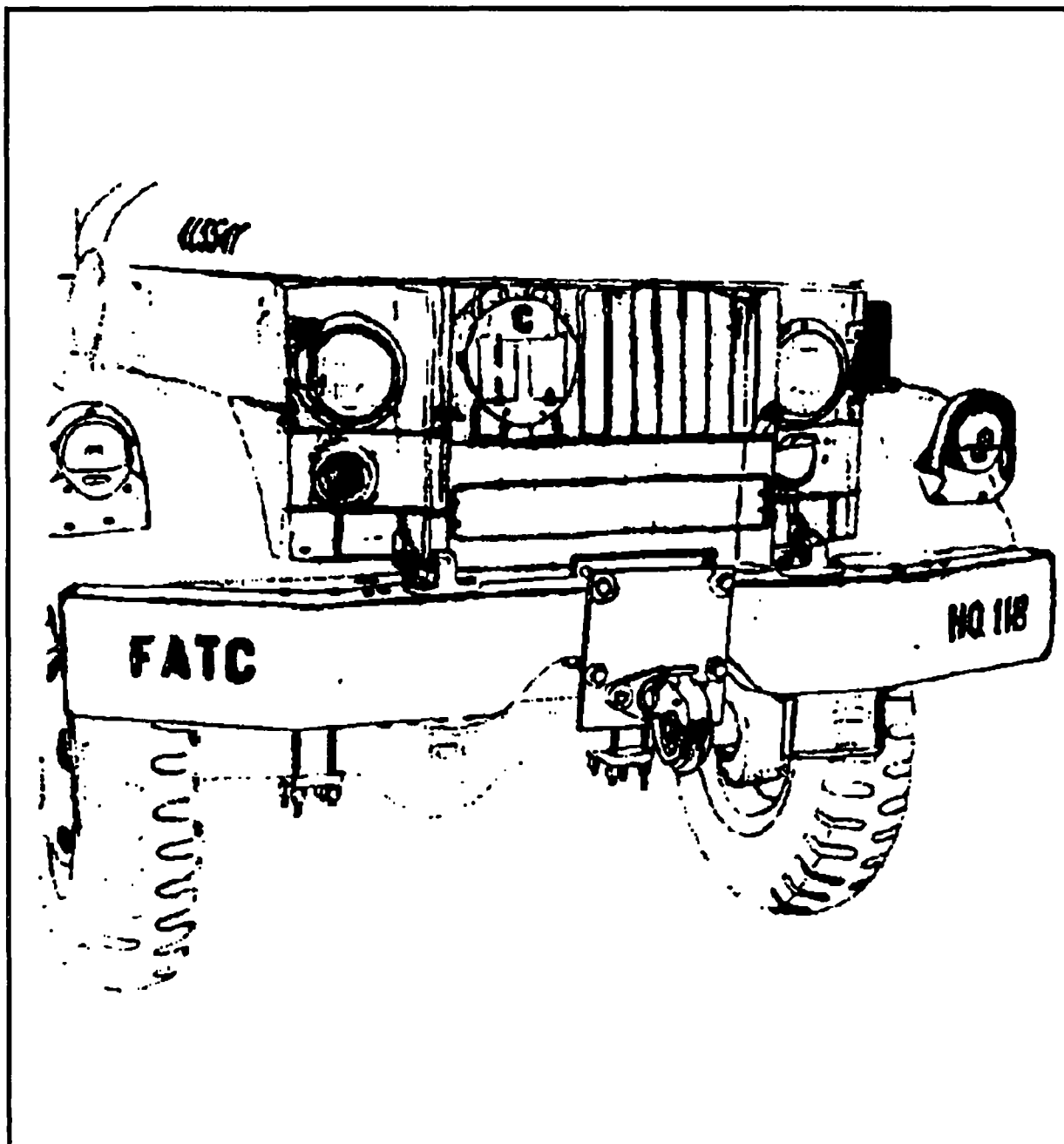
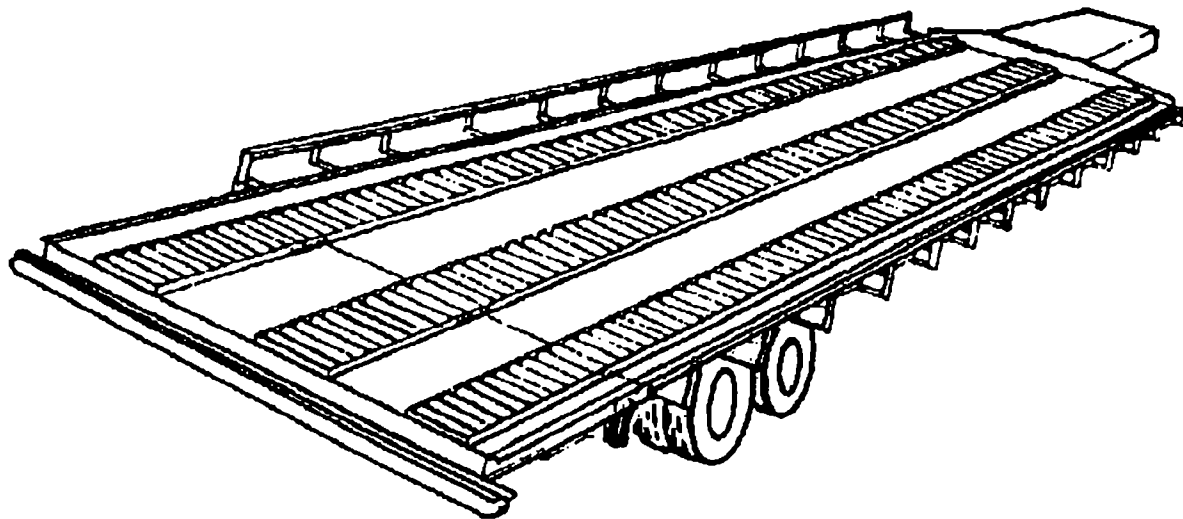


Figure F-16. Front-Mounted Pintle Hook.

ROLLERIZED FLATBED TRUCKS

Rollerized flatbed trucks (Figure F-17) come in a variety of sizes, lengths, and load-carrying capabilities. Most flatbed trailers (not lowboys) may be modified by attaching lengths of rollers to accommodate building, transporting, storing, and

loading cargo on 463L pallets. These flatbeds facilitate the speedy handling of palletized cargo, particularly when K loaders are not available. The trailers will also allow units to stage pallets in chalk order and construct married pallets without tying a K loader up with the load.



SPECIFICATIONS

Tine Length	40 inches
Lift Capacity	4,000 pounds
Shipping Weight	8,365 pounds

Figure F-17. Rollerized Flatbed Truck (Typical).



GLOSSARY

Section I. ABBREVIATIONS AND ACRONYMS

AACG	Arrival Airfield Control Group	DTACC	Deployed Tanker Airfield Control Center
AALPS	Automated Air Load Planning System	DTO	division transportation officer
AC	aircraft	ECP	entry control point
ACL	allowable cabin load	EUCOM	European Command
ADPC	Air Deployment Planning Course	FM	field manual
AFM	Air Force manual	FORSCOM	Forces Command
AFP	Air Force pamphlet	FS	fuselage station
AFR	Air Force regulation	fwd	forward
AGL	above ground level	g	force of gravity
ALCE	Airlift Control Element	GSS	Graphics System Software
ALCS	Airlift Control Squadron	GVW	gross vehicle weight
AMC	Air Mobility Command	HQ	headquarters
AMCP	Air Mobility Command pamphlet	ID	identification
AMCR	Air Mobility Command regulation	ITO	installation transportation office
APO	Army post office	JCS	Joint Chiefs of Staff
APOD	aerial port of debarkation	KB	kilobytes
APOE	aerial port of embarkation	LAPES	Low Altitude Parachute Extraction System
AR	Army regulation	LAT	latitude
ATP	Allied tactical publication	lb	pound
AT/RT	all terrain/rough terrain	LFTCPAC	Landing Force Training Command, Pacific
CALM	Computer-Aided Load Manifesting System	lox	liquid oxygen
CB	center of balance	LON	longitude
CCB	combined center of balance	MAC	Military Airlift Command
CFA	call forward area	max	maximum
CG	center of gravity	MEE	minimum essential equipment
CINC	commander in chief	MHE	materials-handling equipment
CONEX	container express	min	minimum
CONUS	continental United States	mph	miles per hour
CRAF	Civil Reserve Air Fleet	MRE	meals ready to eat
DA	Department of the Army	MTOE	modification table of organization and equipment
D/AACG	Departure/Arrival Airfield Control Group	NA	not applicable
DACG	Departure Airfield Control Group		
deg	degree		
DOD	Department of Defense		
DSN	Defense Switched Network		

No.	number	TAC loader	tactical loader
NSN	national stock number	TACC	Tanker Airlift Control Center
pam	pamphlet	TALCE	Tanker Airlift Control Element
PAX	passenger	TB	technical bulletin
pcs	pieces	TC-ACCIS	Transportation Coordinator - Automated Command and Control Information System
plt	platoon		
PLF	pounds per linear foot	TCC	transportation component command
POM	preparation for overseas movement	TM	technical manual
PP	pallet position	TO	technical order
psi	pounds per square inch	TOE	table(s) of organization and equipment
RAM	random access memory	TRADOC	Training and Doctrine Command
RD	reference datum		
reg	regulation	UMO	unit movement officer
RL	ready line	US	United States
ROPS	rollover protection system	USARPAC	United States Army, Pacific
RT	rough terrain	USMC	United States Marine Corps
SAAF	small austere airfield	USTRANSCOM	United States Transportation Command
sec	section		
SOP	standing operating procedure	WAM	weight, arm, moment
ST	short tons	WESTCOM	Western Command

Section II. DEFINITIONS

aerial port of debarkation (APOD) - A station that serves as an authorized port to process and clear aircraft (scheduled, tactical, and ferried) and traffic for entrance to the country in which located.

aerial port of embarkation (APOE) - A station that serves as an authorized port to process and clear aircraft (scheduled, tactical, and ferried) and traffic for departure from the country in which located.

aircraft commander - A pilot designated as pilot-in-command of a given aircraft. The pilot-in-command is responsible for its safe operation and is in command of all personnel on board.

air-land operation - An operation involving air movement in which personnel and supplies are air-landed at a designated destination for further deployment of units and personnel and further distribution of supplies.

Airlift Control Center - An operation center where the detailed planning, coordinating, and tasking for tactical airlift operations are accomplished. This is the focal point for communications and the source of control and direction for the tactical airlift forces.

Airlift Control Squadron (ALCS) - An in-garrison command and control unit assigned to an AMC wing and designated as a squadron. When not in a deployed posture at home station, the squadron plans for future deployments, coordinates mission support element requirements, attends joint planning conferences, coordinates and monitors joint airborne/air transportability training, and conducts AMC affiliation program training.

airlift force - Includes military strategic and tactical airlift aircraft augmented by the CRAF.

airlift mission - A mission operated to meet an airlift requirement.



